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Today'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 engineering Explore important ethical issues raised by examples of synthetic biology Investigate the BioBuilder labs that probe the design-build-test cycle Test synthetic living systems designed and built by engineers Measure several variants of an enzyme-generating genetic circuit Model "bacterial photography" that changes a strain's light sensitivity Build living systems to produce purple or green pigment Optimize baker's yeast to produce β -carotene This textbook has been conceptualized to provide a detailed description of the various aspects of Systems and Synthetic Biology, keeping the requirements of M.Sc. and Ph.D. students in mind. Also, it is hoped that this book will mentor young scientists who are willing to contribute to this area but do not know from where to begin. The book has been divided into two sections. The first section will deal with systems biology – in terms of the foundational understanding, highlighting issues in biological complexity, methods of analysis and various aspects of modelling. The second section deals with the engineering concepts, design strategies of the biological systems ranging from simple DNA/RNA fragments, switches and oscillators, molecular pathways to a complete synthetic cell will be described. Finally, the book will offer expert opinions in legal, safety, security and social issues to present a well-balanced information both for students and scientists. Molecular Dynamics is a two-volume compendium of the ever-growing applications of molecular dynamics simulations to solve a wider range of scientific and engineering challenges. The contents illustrate the rapid progress on molecular dynamics simulations in many fields of science and technology, such as nanotechnology, energy research, and biology, due to the advances of new dynamics theories and the extraordinary power of today's computers. This

second book begins with an introduction of molecular dynamics simulations to macromolecules and then illustrates the computer experiments using molecular dynamics simulations in the studies of synthetic and biological macromolecules, plasmas, and nanomachines. Coverage of this book includes: Complex formation and dynamics of polymers Dynamics of lipid bilayers, peptides, DNA, RNA, and proteins Complex liquids and plasmas Dynamics of molecules on surfaces Nanofluidics and nanomachines This book review the synthetic approaches used for the synthesis of isocyanates and ureas. Ureas is a group of chemical compounds, structurally contain R'RN-CO-NRR' functional group consist of carbonyl group sandwiched between two moieties of organic amine. Allantoin, hydantoin and carbamide peroxide are a few examples of ureas compounds. The compounds of ureas are strongly related to biuret and on the basis of their structure they are highly correlated to amides, diimides, carbamates, thiocarbamides and carbiimides. The detailed discussion of synthesis of isocyanate and ureas with chemical structure and schemes enhance the understanding of reader. The book also highlights the biological importance of ureas and its derivatives. With detailed studies that not only illustrate the synthetic methodologies but also focus on the pharmacological and medicinal importance of nitrogen containing compounds, this book is a practical, hands-on reference for upper-level undergraduates and graduates students and researchers in the field of medicinal chemistry.

Chemical and Synthetic Biology Approaches to Understand Cellular Functions - Part C, Volume 633, the latest release in the Methods in Enzymology series, continues the legacy of this premier serial. This release includes sections on Next generation probes for molecular imaging in cells, Competitive binding assay for biotin and biotin derivatives, based on avidin and biotin-4-fluorescein, Converting avidin to bind ligands other than biotin, especially steroids, Chemoenzymatic Labeling Strategy, Engineered Siderophores, Small molecules to inhibit bacterial population behavior, NMR tube bioreactor, Small molecule controlled RAS activation system, Small molecule regulated Cas9, the Design and application of synthetic receptors, and much more. Contains the authority of authors who are leaders in their field Provides a comprehensive source on new methods and research in enzymology This book addresses the design of emerging conceptual tools, technologies and systems including novel synthetic parts, devices, circuits, oscillators, biological gates, and small regulatory RNAs (riboregulators and riboswitches), which serve as versatile control elements for regulating gene expression.

Synthetic biology, a rapidly growing field that involves the application of engineering principles in biology, is now being used to develop novel systems for a wide range of applications including diagnostics, cell reprogramming, therapeutics, enzymes, vaccines, biomaterials, biofuels, fine chemicals and many more. The book subsequently summarizes recent developments in technologies for assembling synthetic genomes, minimal genomes, synthetic biology toolboxes, CRISPR-Cas systems, cell-free protein synthesis systems and microfluidics. Accordingly, it offers a valuable resource not only for beginners in synthetic biology, but also for researchers, students, scientists, clinicians, stakeholders and policymakers interested in the potential held by synthetic biology. Synthetic biology is a new area of biological research that combines science and engineering in order to design and build novel biological functions and systems. The definition of synthetic biology has been generally accepted as the engineering of biology: the synthesis of complex, biologically based (or inspired) systems, which display functions that do not exist in nature. This engineering perspective may be applied at all levels of the hierarchy of biological structures from individual molecules to whole cells, tissues and organisms. As with any multi-disciplinary field, there is an immense and rapidly-growing body of literature concerning synthetic biology, with several dedicated journals now available. However, locating the best information, or identifying the hottest topics can be time-consuming. This Specialist Periodical Report presents critical and comprehensive reviews of the recent literature in themed chapters prepared by invited authors from across the globe. The series editors are active in the field, ensuring that the most valuable information is presented in an authoritative manner. The synergy between synthetic biology and biocatalysis is emerging as an important trend for future

sustainable processes. This book reviews all modern and novel techniques successfully implemented in biocatalysis, in an effort to provide better performing enzymatic systems and novel biosynthetic routes to (non-)natural products. This includes the use of molecular techniques in protein design and engineering, construction of artificial metabolic pathways, and application of computational methods for enzyme discovery and design. Stress is placed on current 'hot' topics in biocatalysis, where recent advances in research are defining new grounds in enzyme-catalyzed processes. With contributions from leading academics around the world, this book makes a ground-breaking contribution to this progressive field and is essential reading for graduates and researchers investigating (bio)catalysis, enzyme engineering, chemical biology, and synthetic biology. The book deals with engineering aspects of the two emerging and intertwined fields of synthetic and systems biology. Both fields hold promise to revolutionize the way molecular biology research is done, the way today's drug discovery works and the way bio-engineering is done. Both fields stress the importance of building and characterizing small bio-molecular networks in order to synthesize incrementally and understand large complex networks inside living cells. Reminiscent of computer-aided design (CAD) of electronic circuits, abstraction is believed to be the key concept to achieve this goal. It allows hiding the overwhelming complexity of cellular processes by encapsulating network parts into abstract modules. This book provides a unique perspective on how concepts and methods from CAD of electronic circuits can be leveraged to overcome complexity barrier perceived in synthetic and systems biology.

Synthetic Biology — A Primer (Revised Edition) presents an updated overview of the field of synthetic biology and the foundational concepts on which it is built. This revised edition includes new literature references, working and updated URL links, plus some new figures and text where progress in the field has been made. The book introduces readers to fundamental concepts in molecular biology and engineering and then explores the two major themes for synthetic biology, namely 'bottom-up' and 'top-down' engineering approaches. 'Top-down' engineering uses a conceptual framework of systematic design and engineering principles focused around the Design-Build-Test cycle and mathematical modelling. The 'bottom-up' approach involves the design and building of synthetic protocells using basic chemical and biochemical building blocks from scratch exploring the fundamental basis of living systems. Examples of cutting-edge applications designed using synthetic biology principles are presented, including: the production of novel, microbial synthesis of pharmaceuticals and fine chemicals; the design and implementation of biosensors to detect infections and environmental waste. The book also describes the Internationally Genetically Engineered Machine (iGEM) competition, which brings together students and young researchers from around the world to carry out summer projects in synthetic biology. Finally, the primer includes a chapter on the ethical, legal and societal issues surrounding synthetic biology, illustrating the integration of social sciences into synthetic biology research. Final year undergraduates, postgraduates and established researchers interested in learning about the interdisciplinary field of synthetic biology will benefit from this up-to-date primer on synthetic biology.

Contents: List of Contributors, Preface, Introduction to Biology, Basic Concepts in Engineering Biology, Foundational Technologies, Minimal Cells and Synthetic Life, Parts, Devices and Systems, Modelling Synthetic Biology Systems, Applications of Designed Biological Systems, iGEM, The Societal Impact of Synthetic Biology, Appendices: Proforma of Common Laboratory Techniques, Glossary, Index

Readership: Students, professionals, researchers in biotechnology and bioengineering.

Keywords: Synthetic Biology; Engineering Principles; Biosociety; Biological Engineering; Biotechnology

Key Features: The book is written in a way that is accessible to students and researchers from different disciplines. The authors are part of the internationally recognised Centre for Synthetic Biology and Innovation and are among the leaders in this field. The genomic revolution has opened up systematic investigations and engineering designs for various life forms. Systems biology and synthetic biology are emerging as two complementary approaches, which embody the breakthrough in biology and invite application of engineering

principles. Systems Biology and Synthetic Biology emphasizes the similarity between biology and engineering at the system level, which is important for applying systems and engineering theories to biology problems. This book demonstrates to students, researchers, and industry that systems biology relies on synthetic biology technologies to study biological systems, while synthetic biology depends on knowledge obtained from systems biology approaches. For nearly forty years, using recombinant DNA tools, researchers, and then businesses, have genetically engineered organisms by transferring naturally occurring genes from one organism into another. Doing so modifies the genetic code of living cells, imparting new traits and achieving desired results; this is done in the production of proteins, pharmaceuticals, and seeds. Synthetic biology, argues Solomon, could free scientists from the need to find natural genes to make such desired modifications. Synthetic biology permits more complex and sophisticated bioengineering than what can be achieved through previous genetic modification techniques. Drawing on non-biological scientific and engineering disciplines, including information technology and nanotechnology, synthetic biology strives to rearrange an organism's genes on a far wider scale by rewriting its genetic code, the chemical instructions need to design, assemble, and operate a species. By allowing the writing of artificial genetic codes, synthetic biology can transform existing industries and spawn new ones, creating new products as well as radically reshaping existing items. Arguing for self-regulation by the scientific and business communities, Lewis D. Solomon recommends a policy framework that would guard against governmental overregulation, which could create a barrier to innovation. Although synthetic biotechnology holds considerable social and economic potential, absent a nurturing regulatory climate, it may prove difficult to translate research discoveries into commercially viable applications. A range of views on the morality of synthetic biology and its place in public policy and political discourse. Synthetic biology, which aims to design and build organisms that serve human needs, has potential applications that range from producing biofuels to programming human behavior. The emergence of this new form of biotechnology, however, raises a variety of ethical questions—first and foremost, whether synthetic biology is intrinsically troubling in moral terms. Is it an egregious example of scientists “playing God”? Synthetic Biology and Morality takes on this threshold ethical question, as well as others that follow, offering a range of philosophical and political perspectives on the power of synthetic biology. The contributors consider the basic question of the ethics of making new organisms, with essays that lay out the conceptual terrain and offer opposing views of the intrinsic moral concerns; discuss the possibility that synthetic organisms are inherently valuable; and address whether, and how, moral objections to synthetic biology could be relevant to policy making and political discourse. Variations of these questions have been raised before, in debates over other biotechnologies, but, as this book shows, they take on novel and illuminating form when considered in the context of synthetic biology. Contributors John Basl, Mark A. Bedau, Joachim Boldt, John H. Evans, Bruce Jennings, Gregory E. Kaebnick, Ben Larson, Andrew Lustig, Jon Mandle, Thomas H. Murray, Christopher J. Preston, Ronald Sandler In the final years of the twentieth century, emigres from mechanical and electrical engineering and computer science resolved that if the aim of biology was to understand life, then making life would yield better theories than experimentation. Sophia Roosth, a cultural anthropologist, takes us into the world of these self-named synthetic biologists who, she shows, advocate not experiment but manufacture, not reduction but construction, not analysis but synthesis. Roosth reveals how synthetic biologists make new living things in order to understand better how life works. What we see through her careful questioning is that the biological features, theories, and limits they fasten upon are determined circularly by their own experimental tactics. This is a story of broad interest, because the active, interested making of the synthetic biologists is endemic to the sciences of our time." Presenting a unique perspective on state-of-the-art physical gels, this interdisciplinary guide provides a complete, critical analysis of the field and highlights recent developments. It shows the interconnections between the key aspects of gels, from molecules and structure through to rheological and functional properties,

with each chapter focusing on a different class of gel. There is also a final chapter covering innovative systems and applications, providing the information needed to understand current and future practical applications of gels in the pharmaceutical, agricultural, cosmetic, chemical and food industries. Many research teams are involved in the field of gels, including theoreticians, experimentalists and chemical engineers, but this interdisciplinary book collates and rationalises the many different points of view to provide a clear understanding of these complex systems for researchers and graduate students. This book provides a comprehensive, up-to-date overview of the opportunities and challenges of the complex field of synthetic biology, which combines various scientific disciplines. The emerging field of synthetic biology employs biotechnological approaches to recreate and enhance basic biological structures, intracellular processes and whole organisms. The book addresses a broad range of topics, including redesigning complex metabolic pathways, DNA/RNA and protein engineering, as well as novel synthetic biomaterials. It discusses both "bottom up" and "top down" approaches and presents the latest genome engineering tools with predictions about how these could change our way of thinking and working. Since the use of synthetic biology raises a number of ethical questions, a chapter is devoted to public awareness and risk management. The book is of interest to scientists from both academia and industry, as well as PhD students and postdocs working in the field. The origin of life from inanimate matter has been the focus of much research for decades, both experimentally and philosophically. Luisi takes the reader through the consecutive stages from prebiotic chemistry to synthetic biology, uniquely combining both approaches. This book presents a systematic course discussing the successive stages of self-organisation, emergence, self-replication, autopoiesis, synthetic compartments and construction of cellular models, in order to demonstrate the spontaneous increase in complexity from inanimate matter to the first cellular life forms. A chapter is dedicated to each of these steps, using a number of synthetic and biological examples. With end-of-chapter review questions to aid reader comprehension, this book will appeal to graduate students and academics researching the origin of life and related areas such as evolutionary biology, biochemistry, molecular biology, biophysics and natural sciences. Synthetic Biology provides a framework to examine key enabling components in the emerging area of synthetic biology. Chapters contributed by leaders in the field address tools and methodologies developed for engineering biological systems at many levels, including molecular, pathway, network, whole cell, and multi-cell levels. The book highlights exciting practical applications of synthetic biology such as microbial production of biofuels and drugs, artificial cells, synthetic viruses, and artificial photosynthesis. The roles of computers and computational design are discussed, as well as future prospects in the field, including cell-free synthetic biology and engineering synthetic ecosystems. Synthetic biology is the design and construction of new biological entities, such as enzymes, genetic circuits, and cells, or the redesign of existing biological systems. It builds on the advances in molecular, cell, and systems biology and seeks to transform biology in the same way that synthesis transformed chemistry and integrated circuit design transformed computing. The element that distinguishes synthetic biology from traditional molecular and cellular biology is the focus on the design and construction of core components that can be modeled, understood, and tuned to meet specific performance criteria and the assembly of these smaller parts and devices into larger integrated systems that solve specific biotechnology problems. Includes contributions from leaders in the field presents examples of ambitious synthetic biology efforts including creation of artificial cells from scratch, cell-free synthesis of chemicals, fuels, and proteins, engineering of artificial photosynthesis for biofuels production, and creation of unnatural living organisms. Describes the latest state-of-the-art tools developed for low-cost synthesis of ever-increasing sizes of DNA and efficient biological of proteins, pathways, and genomes. Highlights key technologies for analyzing biological systems at the genomic, proteomic, and metabolomic levels which are especially valuable in pathway, whole cell, and multi-cell applications. Details mathematical modeling tools and computational tools

which can dramatically increase the speed of the design process as well as reduce the cost of development. Synthetic biology involves the rational design and construction of biological components and systems from genetic elements and metabolic pathways to entirely new organisms. Progress in this field has been rapid, and it promises to significantly expand our capabilities in biotechnology, medicine, and agriculture. Written and edited by experts in the field, this collection from Cold Spring Harbor Perspectives in Biology examines the tools and techniques employed by synthetic biologists, how these may be used to develop new drugs, diagnostic approaches, food sources, and clean energy, and what the field of synthetic biology has taught us about natural living systems. The contributors discuss advances in DNA synthesis and assembly, genome editing (e.g., CRISPR/Cas9), and artificial genetic systems. Progress in designing complex genetic switches and circuits, expanding the genetic code, modifying cellular organization, producing proteins using cell-free systems, and developing biodesign automation tools is also covered. The authors also explore ways to produce new organisms and products that have particular attributes—for example, microbial "molecular factories," synthetic organs and tissues, and plants with novel traits. This volume is an essential resource for molecular, cell, and systems biologists who seek to engineer living systems for human benefit. "Bold and provocative... Regenesi s tells of recent advances that may soon yield endless supplies of renewable energy, increased longevity and the return of long-extinct species."—New Scientist

In *Regenesi s*, Harvard biologist George Church and science writer Ed Regis explore the possibilities—and perils—of the emerging field of synthetic biology. Synthetic biology, in which living organisms are selectively altered by modifying substantial portions of their genomes, allows for the creation of entirely new species of organisms. These technologies—far from the out-of-control nightmare depicted in science fiction—have the power to improve human and animal health, increase our intelligence, enhance our memory, and even extend our life span. A breathtaking look at the potential of this world-changing technology, *Regenesi s* is nothing less than a guide to the future of life. *Designing Human Practices* is a detailed account of this anthropological experiment and, ultimately, its rejection. This book provides an introduction to this exciting and relatively new subject with chapters covering natural and synthetic polymers, colloids, surfactants and liquid crystals highlighting the many and varied applications of these materials. Written by an expert in the field, this book will be an essential reference for people working in both industry and academia and will aid in understanding of this increasingly popular topic. Contains a new chapter on biological soft matter Newly edited and updated chapters including updated coverage of recent aspects of polymer science. Contain problems at the end of each chapter to facilitate understanding Synthetic biology -- unlike any research discipline that precedes it -- has the potential to bypass the less predictable process of evolution to usher in a new and dynamic way of working with living systems. Ultimately, synthetic biologists hope to design and build engineered biological systems with capabilities that do not exist in natural systems -- capabilities that may ultimately be used for applications in manufacturing, food production, and global health. Importantly, synthetic biology represents an area of science and engineering that raises technical, ethical, regulatory, security, biosafety, intellectual property, and other issues that will be resolved differently in different parts of the world. As a better understanding of the global synthetic biology landscape could lead to tremendous benefits, six academies -- the United Kingdom's Royal Society and Royal Academy of Engineering, the United States' National Academy of Sciences and National Academy of Engineering, and the Chinese Academy of Science and Chinese Academy of Engineering -- organized a series of international symposia on the scientific, technical, and policy issues associated with synthetic biology. *Positioning Synthetic Biology to Meet the Challenges of the 21st Century* summarizes the symposia proceedings. Chemistry plays a very important role in the emerging field of synthetic biology. In particular, chemical synthetic biology is concerned with the synthesis of chemical structures, such as proteins, that do not exist in nature. With contributions from leading international experts, *Chemical Synthetic Biology* shows how chemistry underpins synthetic

biology. The book is an essential guide to this fascinating new field, and will find a place on the bookshelves of researchers and students working in synthetic chemistry, synthetic and molecular biology, bioengineering, systems biology, computational genomics, and bioinformatics. The international symposium entitled "Opportunities and Challenges in the Emerging Field of Synthetic Biology" was held in July 2009 in Washington, DC under the auspices of the United States National Academies, the Organisation for Economic ... A review of the interdisciplinary field of synthetic biology, from genome design to spatial engineering. Written by an international panel of experts, Synthetic Biology draws from various areas of research in biology and engineering and explores the current applications to provide an authoritative overview of this burgeoning field. The text reviews the synthesis of DNA and genome engineering and offers a discussion of the parts and devices that control protein expression and activity. The authors include information on the devices that support spatial engineering, RNA switches and explore the early applications of synthetic biology in protein synthesis, generation of pathway libraries, and immunotherapy. Filled with the most recent research, compelling discussions, and unique perspectives, Synthetic Biology offers an important resource for understanding how this new branch of science can improve on applications for industry or biological research. Many potential applications of synthetic and systems biology are relevant to the challenges associated with the detection, surveillance, and responses to emerging and re-emerging infectious diseases. On March 14 and 15, 2011, the Institute of Medicine's (IOM's) Forum on Microbial Threats convened a public workshop in Washington, DC, to explore the current state of the science of synthetic biology, including its dependency on systems biology; discussed the different approaches that scientists are taking to engineer, or reengineer, biological systems; and discussed how the tools and approaches of synthetic and systems biology were being applied to mitigate the risks associated with emerging infectious diseases. The Science and Applications of Synthetic and Systems Biology is organized into sections as a topic-by-topic distillation of the presentations and discussions that took place at the workshop. Its purpose is to present information from relevant experience, to delineate a range of pivotal issues and their respective challenges, and to offer differing perspectives on the topic as discussed and described by the workshop participants. This report also includes a collection of individually authored papers and commentary. Synthetic biology is becoming one of the most dynamic new fields of biology, with the potential to revolutionize the way we do biotechnology today. By applying the toolbox of engineering disciplines to biology, a whole set of potential applications become possible ranging very widely across scientific and engineering disciplines. Some of the potential benefits of synthetic biology, such as the development of low-cost drugs or the production of chemicals and energy by engineered bacteria are enormous. There are, however, also potential and perceived risks due to deliberate or accidental damage. Also, ethical issues of synthetic biology just start being explored, with hardly any ethicists specifically focusing on the area of synthetic biology. This book will be the first of its kind focusing particularly on the safety, security and ethical concerns and other relevant societal aspects of this new emerging field. The foreseen impact of this book will be to stimulate a debate on these societal issues at an early stage. Past experiences, especially in the field of GM-crops and stem cells, have shown the importance of an early societal debate. The community and informed stakeholders recognize this need, but up to now discussions are fragmentary. This book will be the first comprehensive overview on relevant societal issues of synthetic biology, setting the scene for further important discussions within the scientific community and with civil society. Volume 608 of the series Methods in Enzymology covers key aspects of enzyme discovery, engineering tools and platforms, and examples of applications in the enzymology of synthetic biology. Detailed methods for laboratory use of enzymes in synthetic biology applications Informative case history examples illustrating how enzyme and metabolic engineering are used to generate new products Emphasises latest developments in laboratory automation for the engineering of biology Covers many aspects of the design, build,

test, learn cycle used in synthetic biology Synthetic biology aims to make biology easier to engineer and to program. Thanks to advances in computing power, the ability to make long tracts of DNA, new tools like CRISPR that can be used to edit genomes, and the enthusiasm of young scientists and even amateurs who want to enter the field, synthetic biology is poised to change the future of medicine, agriculture, and manufacturing. Yet, while this new field promises vast opportunities and benefits, there are also risks. There are biosecurity risks that these technologies will be deliberately used for harm; safety risks to people and the environment; ethical and social considerations for how to apply these technologies; and there are risks to the competitiveness of nations that do not invest in these technologies that are likely to spur economic growth. This volume is dedicated to a discussion of what can be done to minimize risks and maximize the benefits of synthetic biology. Praise for Synthetic Biology: Safety, Security, and Promise "There can be no doubt that advances in the life sciences, including new insights and tools provided by synthetic biology, place us in a position to create exciting and novel products and approaches for patients in need. Gigi Gronvall describes that promise but also lays forth critical policy concerns that need to be addressed so that we don't risk safety, security, or the competitiveness of US science." - Margaret Hamburg, MD, Former FDA Commissioner and Foreign Secretary, National Academy of Medicine "Synthetic biology gives us tools that can help tackle global problems that affect humanity-but for that to happen, the risks of bioterror or bio-error need to be dealt with and managed, as well. Gronvall clearly describes the policy challenges that must be addressed and concludes with steps to enhance US leadership and competitiveness in the global bio-economy." - J. Craig Venter, PhD, founder, chairman, and CEO of the J. Craig Venter Institute and co-founder, executive chairman and co-chief scientist of Synthetic Genomics, Inc. "For those of us working in the lab, it is important to embrace conversations with those who aren't - including strategies for biological security, to create new synthetic biology products - with respect for facts about GMO risk/benefit balances, creating a culture of safe lab practices and norms worldwide. Gigi Gronvall dissects such issues at stake in synthetic biology and presents a pragmatic and scientifically responsive path forward for anyone in a position to influence, regulate, decide upon, or benefit from the science to follow." - George Church, PhD, Professor of Genetics Harvard Medical School and Director of PersonalGenomes.org "Synthetic biology presents some of the greatest challenges and opportunities of the 21st Century. Gigi Gronvall navigates a path to follow, to make sure risks are addressed and opportunities are not squandered. It should be read by all concerned about national security." - The Honorable Andrew Weber, head of global partnerships for Metabiota and former Assistant Secretary of Defense for Nuclear, Chemical, and Biological Defense Programs Synthetic biology is a dynamic, young, ambitious, attractive, and heterogeneous scientific discipline. It is constantly developing and changing, which makes societal evaluation of this emerging new science a challenging task, prone to misunderstandings. Synthetic biology is difficult to capture, and confusion arises not only regarding which part of synthetic biology the discussion is about, but also with respect to the underlying concepts in use. This book offers a useful toolbox to approach this complex and fragmented field. It provides a biological access to the discussion using a 'layer' model that describes the connectivity of synthetic or semisynthetic organisms and cells to the realm of natural organisms derived by evolution. Instead of directly reviewing the field as a whole, firstly our book addresses the characteristic features of synthetic biology that are relevant to the societal discussion. Some of these features apply only to parts of synthetic biology, whereas others are relevant to synthetic biology as a whole. In the next step, these new features are evaluated with respect to the different areas of synthetic biology. Do we have the right words and categories to talk about these new features? In the third step, traditional concepts like "life" and "artificiality" are scrutinized with regard to their discriminatory power. This approach may help to differentiate the discussion on synthetic biology. Lastly our refined view is utilized for societal evaluation. We have investigated the public views and attitudes to synthetic biology. It also includes the analysis of ethical, risk and legal questions,

posed by present and future practices of synthetic biology. This book contains the results of an interdisciplinary research project and presents the authors' main findings and recommendations. They are addressed to science, industry, politics and the general public interested in this upcoming field of biotechnology. Systems and Synthetic Metabolic Engineering provides an overview of the development of metabolic engineering within medicine that is fueled by systems and synthetic biology. These newly developed, successful strategies of metabolic engineering guide the audience on how to propose and test proper strategies for metabolic engineering research. In addition to introductory, regulatory and challenges in the field, the book also covers dynamic control and autonomous regulation to control cell metabolism, along with computational modeling and industrial applications. The book is written by leaders in the field, making it ideal for synthetic biologists, researchers, students and anyone working in this area. Discusses the current progress of metabolic engineering, focusing on systems biology and synthetic biology. Covers introductory, regulatory, strategies, production and challenges in the field. Written technically for synthetic biologists, researchers, students, industrialists, policymakers and stakeholders. Scientific advances over the past several decades have accelerated the ability to engineer existing organisms and to potentially create novel ones not found in nature. Synthetic biology, which collectively refers to concepts, approaches, and tools that enable the modification or creation of biological organisms, is being pursued overwhelmingly for beneficial purposes ranging from reducing the burden of disease to improving agricultural yields to remediating pollution. Although the contributions synthetic biology can make in these and other areas hold great promise, it is also possible to imagine malicious uses that could threaten U.S. citizens and military personnel. Making informed decisions about how to address such concerns requires a realistic assessment of the capabilities that could be misused. Biodefense in the Age of Synthetic Biology explores and envisions potential misuses of synthetic biology. This report develops a framework to guide an assessment of the security concerns related to advances in synthetic biology, assesses the levels of concern warranted for such advances, and identifies options that could help mitigate those concerns. Synthetic biology gives us a new hope because it combines various disciplines, such as genetics, chemistry, biology, molecular sciences, and other disciplines, and gives rise to a novel interdisciplinary science. We can foresee the creation of the new world of vegetation, animals, and humans with the interdisciplinary system of biological sciences. These articles are contributed by renowned experts in their fields. The field of synthetic biology is growing exponentially and opening up new avenues in multidisciplinary approaches by bringing together theoretical and applied aspects of science. Synthetic biology encompasses a variety of different approaches, methodologies and disciplines, and many different definitions exist. This Volume of Methods in Enzymology has been split into 2 Parts and covers topics such as Measuring and Engineering Central Dogma Processes, Mathematical and Computational Methods and Next-Generation DNA Assembly and Manipulation. Encompasses a variety of different approaches, methodologies and disciplines. Split into 2 parts and covers topics such as measuring and engineering central dogma processes, mathematical and computational methods and next-generation DNA assembly and manipulation.

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