Abstract

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Designing Microbial Cell Factories Through the Application of Metabolic Engineering

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Abstract

Concepts and Applications of Metabolic Engineering for Metabolites Production

New avenues for a deeper knowledge of the organism's physiology and metabolism have been made possible with the advancement in molecular biology tools and access to the whole genome sequencing data that open the doors for metabolic engineers and sped up the metabolic engineering application. It is pertinent to say that without molecular biology which has numerous applications in modern biotechnology, metabolic engineering couldn't be in its present bloomy position. Metabolic engineering permits the introduction of novel, beneficial features such as drought and salt tolerance in plant biotechnology, assisting the discovery of disease-causing genes and their therapy in medical biotechnology. Nikel & de Lorenzo, (2021) accentuated the use of metabolic engineering for the degradation of recalcitrant compounds in environmental biotechnology. Metabolic engineering can fabricate the coveted metabolite using renewable resources by altering the endogenous pathways or employing the heterologous biosynthetic pathways in microbes. Thus, microbes perform as a cell factory for producing different metabolites using several native and non-native enzymes. Due to this, metabolic engineers and synthetic biologists can produce a plethora of metabolites in cell factories in a jiff.

In this vain, it is the right time that S.Y. Lee (Distinguished Professor at the Department of Chemical and Biomolecular Engineering at the Korea Advanced Institute of Science and Technology, Korea), J. Nielsen (Professor and Director at Chalmers University of Technology, Sweden) , and G. Stephanopoulos (W. H. Dow Professor of Chemical Engineering at the Massachusetts Institute of Technology, MIT, USA) co-edited a contributing book titled "Metabolic Engineering: Concepts and Applications" recently published by WILEY-VCH GmbH, Germany. These three scientists are the pioneers and trailblazers of metabolic engineering/synthetic biology, I must say the "Fathers of Metabolic Engineering" and they have compiled an up-to-date overview of the field in the said book.

The book straddles the line between being an introductory book offering an introduction to the discipline and an accessible desk reference for innovative case studies for the professional metabolic engineer. This book has twenty-two chapters and has two parts: ideas and applications of metabolic engineering.

The idea's part starts with exploring history, viewpoints, and recommendations for further research in metabolic engineering. An incisive discussion of modeling and simulation at the genome level that has emerged in recent decades as a crucial tool for comprehending metabolism and developing metabolic engineering approaches is then provided. The book focuses on how data obtained after stable isotope tagging is used to calculate the metabolic fluxes. As metabolic flux analysis is crucial to metabolic engineering because it gives quantitative data on a metabolic network's distribution. The authors' emphasized the use of proteome constraints for the genome-scale metabolic simulation, which might be more effective and realistic. The authors highlighted the use of kinetic models for investigating the pathway transitions while considering the substrate and enzyme concentration as well as the typical characteristics of the catalyst. Moreover, analysis of metabolic control—a hypothetical framework to comprehend how alterations in enzymatic activity impact the metabolic network fluxes and metabolite concentrations has also been discussed. The authors also emphasized the use of metabolic pathway's thermodynamics to check the probability of metabolic pathways that are critical for pathway designing, followed by a four-step method for designing metabolic pathways, for instance, identifying the biochemical search space, searching for the pathway, designating enzymes for each reaction step, and assessing the effectiveness of the pathway. It is pertinent to know that without a comprehensive grasp of metabolites, metabolic engineering is impossible, thus, the developing metabolomics trends as well as how to conduct metabolome analysis and data processing have also been debated. Then, in the last chapter of Part 1, genome editing of eukaryotes has been discussed thoroughly, highlighting the significance of universal tools that may be used in several types of cells.

In the application part of the book, each chapter is expounding a specific organism with a special emphasis placed on how metabolic engineering strategies are being used in these respective organisms, for instance, *E. coli, Corynebacteria, Pseudomonas, Bacillus, Yarrowia lipolytica, Clostridia*, yeasts, lactic acid bacteria, actinomycetes, filamentous fungi, and photosynthetic organisms. These chapters demonstrate the application of metabolic engineering strategies to produce a broad variety metabolites, chemicals, and fuels in corresponding species. Although mostly metabolic engineering techniques used in different organisms are common, some have been specially designed and evaluated about the particular host cell also reviewed. The issue of bioremediation is covered in the last chapter considering the significance of creating plans to handle escalating environmental pressures. That demonstrates how crucial metabolic engineering is for "creating something beneficial for us" as well as "changing our environment."

Practicing biotechnologists, metabolic engineers, synthetic biologists, bioprocess engineers, chemical/biochemical engineers, and natural products scientists who want to strengthen their grasp of the area possibly will benefit from the comprehensive compilation of all pertinent metabolic engineering ideas, models, and applications in this book.