Book Review

New trends in applied microbiology

Focus on Biotechnology.
Applied Microbiology. Volume 2.
Edited by Alain Durieux and Jean-Paul Simon Kluwer Academic Publishers, 2001.
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Focus on Biotechnology is an open-ended series of reference volumes produced in cooperation with the Belgium International Chemistry Society. This volume illustrates the major trends in applied microbiology research with immediate or potential applications. The book consists of specific research papers and overview papers that cover a large range of applications, for example, in the food and health sectors, environmental technology and fine chemical production using various types of microorganisms, particularly yeast, fungi and bacteria.

An important field of application is the production of food – one of the oldest areas of biotechnology – which is described in the first part of the book. A lot of research has been done in this field and modern molecular techniques are nowadays used to improve production strains. Starters for the wine industry, including a good overview on the selection and use of yeast and malolactic starters in winemaking, are also described.

Part 2 includes sections on physiology, biosynthesis and metabolic engineering. With the help of tools from systems theory and systems engineering, biological systems can be seen as information processing units in which complex regulatory interactions occur. This book contains a very short survey of the basic concepts of metabolic pathway analysis, describing metabolic control analysis and metabolic flux analysis. Applications involving the glycolysis and galactose metabolism of *Saccharomyces cerevisiae* are described. An increased understanding of the molecular mechanisms of cellular control is an important requirement for the far-reaching appliance of theoretical tools – an example, is the role of the stringent response in lysine biosysnthesis.

In the production process, the modes and parameters of plant operation have a crucial role. For example, aeration causes various effects on the surface properties and flocculation of brewers' yeast. Preculture conditions, nutritional limitations and therefore feeding strategies also have to be considered. The understanding of signal transduction networks is also an important prerequisite step in the development of the production process. Different signal transduction modules and levels can be described and regulation has to be considered on different levels, for example the cell cycle, genetic level and metabolic levels.

Novel approaches to the study of microorganisms have to be developed; we need to look more closely at the inside of the cell. New analytical methods, such as isotopic ratio mass spectrometry, provide opportunities for the quantitative understanding of metabolism. The examination of the mechanical properties of the cell, especially those of different bacterial species, is introduced in this book.

Many new opportunities are arising in the field of applied microbiology. Some interesting examples are described (e.g. bacterial feather degradation, removal of lead ions and hydrocarbon utilisation by soil bacteria), which shows the variety of feasible biological processes in industry. One of the important steps to advance current and future biotechnology is to open up the different resources and potential of organisms, which is being pushed by many industrial and academic screening centers.

Security and preservation of bioproducts, especially food, is a fundamental requirement. Molecular detection and typing of foodborne bacterial pathogens is one example of the research that is done in this area. Bioencapsulation technology in meat preservation is another.

This book addresses many different fields of applied microbiology within a few papers. It gives ideas on new trends but does not gather the whole area of applied microbiology and so the reader misses a broader overview of the whole field. Many concepts are sketched and suggestions for further reading are provided. The book will be of interest to researchers working in the relevant fields and for people who want to get some ideas and examples about what kind of work is done in applied microbiology.

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Modeling and control in bioprocesses

Bioreaction Engineering. Modeling and control.
edited by Karl Schügerl and Karl-Heinz Bellgardt, Springer, 2000.
DM 369 (hbk) (604 pages)
ISBN 3 540 66906 X

Modeling of biological processes is an important tool for the optimal design and characterization of industrial processes. This is a complex task because biological reactions are influenced by the chemical environment, such as the level of nutrients and product concentration, and also by the physical conditions. Metabolism and the mechanisms of its regulation are still not fully understood and the variations of physical conditions caused by fluid dynamics and mass transfer have to be looked at in simplified ways. Thus, mathematical descriptions of these processes can be simplified, but can still be useful to describe those effects that are of great importance for process design, scale-up, optimization and automatic control.

The information is arranged in four parts, each of which includes several chapters written by different authors. The contributors have a wide collection of publications in bioreaction engineering. The first part of the book contains general principles and techniques with regard to reactor and process models, control and metabolic

flux analysis. General principles applied for particular bioreactors models are included in the second part. The book concludes with examples of modeling selected processes of industrial importance. The general models are applied to describe the kinetics and control strategies in the production of baker's yeast, beer, lactic acid, recombinant proteins and β-lactam antibiotics. The last section includes some applications for metabolic flux analysis and metabolic design for yeast, bacterial and mammalian cells.

The book introduces the methods used in the various stages of designing industrial processes. It offers an overview of the different types of biological models at various levels of complexity, beginning with simple formal-kinetic models over structured models, and moving on to segregated population models. Improvements in understanding cellular metabolism are well illustrated using current methods for flux quantification, and the book introduces several existing techniques, such as metabolic balancing and isotopic labeling combined with NMR spectroscopy methods. The importance of the accuracy and reliability of measured data for process modeling and control is carefully discussed in the text. Also, an introduction to automatic control for optimizing production efficiency and the design of adaptive linearizing control of bioprocesses are adequately outlined.

The physiological state of microorganisms and their behavior is intimately bound to the mixing effects and the transport effects in bioreactors. The application of various approaches to bioreactor modeling is outlined, covering the computational fluid-dynamic technique, stirred tank and bubble column bioreactor with results good enough to serve as basic reactor models.

The book is well written, well structured and easy to read and contains relevant references. This is a useful book that gives a good global view of the modeling and control of bioprocesses. It is highly recommended for anyone who wants to know the most important current and future perspectives in bioreaction engineering.

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Profile

Profile – Richard A. Mathies

Richard A. Mathies (Fig. 1) is a professor of chemistry at the University of California (UC) at Berkeley. His early work at UC was on the use of resonance Raman and time-resolved optical spectroscopy to elucidate the structure and reaction dynamics of energy and information-transducing photoactive proteins called rhodopsins. His work on the Human Genome Project led to the development of high-throughput platform technologies including capillary array electrophoresis and energy transfer fluorescent dye labels for DNA sequencing and analysis. He has also pioneered the development of microfabricated capillary electrophoresis devices, capillary array electrophoresis microplates and microfabriated integrated sample preparation and detection methods. He is the co-founder of the Center for Analytical Biotechnology at UC Berkeley. Mathies was interviewed at the BIOMEMS and Biomedical Nanotechnology conference in Columbus, Ohio, 21–25 September 2001, where he gave a talk about capillary array electrophoresis-based microprocessors. Such devices could be used as point-of-care clinical and genetic analyzers, in integrated microfluidic sequencing chips and in DNA-based computing.

Who awarded your first grant and what was it for?
My first award was an NIH grant to examine the molecular basis of visual excitation in rhodopsin using resonance Raman spectroscopy. This basic science project led to our development of high-sensitivity confocal detection systems as well as a better understanding of the fundamental detection limits imposed by photodestruction. These new understandings provided the underpinning for our work applying high sensitivity confocal fluorescence scanning to DNA sequencing and diagnostics.

Fig. 1. Prof. Richard A. Mathies. (Photograph courtesy of The Mathies Lab.)

What is the biggest obstacle or challenge in the field?
There are social as well as technical issues to be overcome. On the technical side, the big challenge is the integration of the plethora of microfluidic technologies that have been developed into robust analysis systems. Although this challenge is significant, I think that great progress will be made on the integration issue in the next five years. On the more challenging social side we must address the ethical, legal and social issues that will arise from the wide application of microfluidic technologies. Microtechnologies such as point-of-care genetic analysis and portable forensic analyzers raise issues about privacy, insurance discrimination and so on. Also, the Human Genome Project is often erroneously associated in the press with human cloning technology thereby raising concerns among the public. The difficult legal and legislative issues need to be resolved and the public needs to be educated about what these new measurements and technologies mean and what they don't mean. Education will also be important in the medical community; doctors need to understand and trust the new technology before they can advise and inform their

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