

Comprehensive Biotechnology

Murray Moo-Young, Editor-in-Chief, Pergamon Press, Oxford, 1985, 4-volume set, \$995

Volume 1—The Principles of Biotechnology: Scientific Fundamentals

Edited by Alan T. Bull and Howard Dalton, 688 pp.

Comprehensive Biotechnology is a four volume treatise that sets out to cover the principles, methods and application of biotechnology. This series predominantly reflects mainstream industrial biotechnology. Plant and medical biotechnology are considered briefly. Volume I addresses "Scientific Principles" in two sections: Biology/Genetics and Chemistry/Biochemistry. The introduction to microbes (plus animal and plant cells—Chap. 16) is succinctly presented in the first 50 pages. Even in this condensed manner (which is representative of the whole text), considerable detail is evident. Thus the engineer is introduced to such selective isolation tricks as the use of snakeskin as a bait. The microbiologist is once again reminded of the attributes of continuous culture for selection, while noting the consortial nature of the resultant population. An entire chapter addresses the importance of storing cultures. The limitations of the well-known storage method of "throw the culture in the back of the refrigerator" are clearly illustrated. The "care" of microbes is further addressed through Chapters 7–16. There is a balanced (bacterial/fungal) selection of topics on growth—modes, dynamics, stoichiometry, and effects of the environment. Additional chapters discuss such critical topics (often given short shrift) as microbial nutrition, design of fermentation media and the aging and death of microbes. The final chapter in the Biology section addresses mixed cultures. This is particularly timely, especially as most fermentation engineers tend to behave as monocultural ecologists, while practical systems such as waste treatment plants are somewhat more complex. Genetic methodologies, perhaps misplaced as early chapters 5 and 6, are succinct, current reviews.

The second section addresses chemical and biochemical fundamentals. It is comprised of a series of ten erudite essays of the physiology of the "industrial cell," plus four chapters elucidating enzymes from kinetics to evolution, and finally two key chapters on the regulatory aspects of metabolite synthesis. The chapters on fatty acid and metabolite biosynthesis, aromatic metabolism, photosynthesis and enzymes are replete with figures, diagrams and tables.

One can quibble with certain features of the text. For instance, including a diagrammatic outline of the interrelationships between the bacterial groups plus a few photographs of microbes would give the neophyte a better perspective of the microbial kingdom; the microscope appears to have fallen from favor in biotechnology. The discussions on genetics, though excellent, gloss over the structure of DNA and can perhaps leave the engineer in somewhat of a vacuum. There are occasional lapses such as the poor illustrative choice of transposon-like structures (p. 66), and statements such as "we have designed a medium for the expression of all clones of a genetically altered population" (p. 41) have little merit without further quantitative definition. However, these are quibbles.

The editorial/advisory board has exerted a strong influence on the text with resultant short focussed chapters of high quality. Duplication of material is essentially non-existent. Volume I of Comprehensive Biotechnology is an excellent balanced presentation of the principles of biotechnology and will indeed serve the intended audience from microbiologist to engineer. It is highly recommended. It is also suggested reading for the myopic British Government, which continues to cut university research programs; Volume I includes presentations by twenty-three British authors, and biotechnology is a rapidly advancing discipline which demands financial support.

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Volume 2—The Principles of Biotechnology: Engineering Considerations

Edited by Arthur E. Humphrey and Charles L. Cooney, 632 pp.

Volume 2 of "Comprehensive Biotechnology" is addressed to chemical and biochemical engineers who require information on mass and energy balances, rates of such processes as fermentations, product recovery and feedstock pretreatment, and the equipment to carry out these processes. On the whole, the editors have achieved this goal.

This book is divided into two sections. Section 1 describes bioreactor design, operation, and control in thirteen chapters (229 pages); these include an excellent review of transport phenomena in bioprocesses, (primarily covering oxygen transfer in fermentors), stirred tank fermentor design and scale-up, tubular bioreactors and imperfectly mixed stirred tanks, non-mechanically agitated bioreactors with power input by liquid kinetic energy and by gas compression, dynamic modelling of fermentation systems, instrumentation and process control in bioreactors, data analysis, and cell and enzyme immobilization techniques. Section 2 has 24 chapters (358 pages) on upstream and downstream processing. Upstream operations include gas compression, air filtration, media sterilization, and heat management. Downstream operations include material handling, cell rupture, centrifugation, broth filtration, microfiltration and ultrafiltration, solvent extraction, aqueous two-phase extraction, ion exchange for antibiotics and proteins, molecular sieve chromatography, affinity chromatography, hydrophobic chromatography, HPLC, distillation, supercritical gas extraction, and electrodialysis.

Each chapter is written by one to three contributors, most of whom are well known experts in their fields. Therefore, this book will serve as an excellent reference for bioprocess engineers. With so many authors, however, the quality and depth of the articles is somewhat uneven. Occasionally material overlaps, for exam-

ple: membrane separations are covered in four chapters, and instrumentation and process control of fermentors are covered in two chapters each. There is a good balance of the academic (twenty-four contributors) and industrial perspectives (twenty contributors). Due to the large number of topics being addressed, one should not expect an in-depth coverage of each. Most chapters are written for a non-specialist and provide adequate information about principles, applications in bioprocessing, equipment, and scale-up, and include enough references to serve as a starting point for self study. References in most chapters are up-to-date through 1983, and a glossary of terms and index is included.

One may question the subject matter or emphasis in some chapters. For example, chapters on immobilization of cells and enzymes emphasize immobilization techniques, and not reactor design and performance. In Section 2, while those unit operations chosen are of interest, rarely used operations such as supercritical gas extraction are included while some very commonly used operations such as crystallization, decolorization, adsorption-desorption, and drying are not. Each unit operation is also treated separately, with no discussion about process synthesis or integration of the unit operations to make the most efficient and economical process. This is an area of great importance to bioprocess engineers, since there are many ways to isolate a product to desired purity. Also, some discussion about the special considerations in bioprocess development, such as: maintaining biological activity during processing, variability of bioreactions compared to chemical reactions, separating large molecular weight compounds with only slight differences in structure, and processing problems caused by contamination would have been useful. Simultaneous fermentation and partial recovery (fermentation coupled with solvent extraction or adsorption) to improve fermentation by removing inhibitory products is another area of interest. Some discussion about the different types of assays used for product control and yield determinations also would have been useful to bioprocess engineers. Clearly, not all topics can be covered in a single book, and as the editors point out, ongoing trends and progress will be covered in supplementary volumes and in Perga-

mon's review journal *Biotechnology Advances*.

On the whole, I think the editors and contributors have done a good job. This book provides a broad introduction to, and an overview of, bioprocess engineering to students and practicing engineers with limited experience. Experienced bioprocess engineers will also find it to be very useful to fill in the gaps in their backgrounds. This book will serve as an excellent reference source, which will be, no doubt, used frequently.

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Volume 3—The Practice of Biotechnology: Current Commodity Products

Edited by Harvey W. Blanch, Stephen Drew, and Daniel I. C. Wang, 1136 pp.

The third volume of "Comprehensive Biotechnology" addresses the application of biotechnology to a wide range of commercial products: health care products, food and beverage products, industrial chemicals, biochemicals, and fuels. For this large undertaking, an approach similar to the Kirk-Othmer Encyclopedia of Chemical Technology was utilized. Various expert authors summarized the historical, current, and future directions of biotechnology as applied to the products of their expertise.

The first section of the book surveys applications to healthcare products, ranging from more mature, developed products such as penicillin to products from recombinant DNA. It is commendable that the majority of the authors are from industry, and are actually responsible for reduction to commercial practice. It is not surprising, then, that the degree of technical detail and economics disclosed is proportional to the product's age. Particularly noteworthy is the section on penicillins by R. W. Swartz, which is significant in that it discusses and reflects on the relative impacts that various disciplines (Microbiology, Biochemical Engineering, Chemical Engineering, etc.) can have on overall process economics. Although written specifically for penicillin, the "lessons

learned" can be translated to almost any application of biotechnology.

The second section discusses food and beverage products. The range and variety of products discussed, from beer, whiskey, cheese, and bakers yeast technology to manufacture of amino acids is fascinating. Historically, these technologies developed independently, with their own nomenclature and approach. Therefore, it is interesting to read about the products with terms explained in a contemporary, scientific language.

The third and final section surveys industrial chemicals, biochemicals, and fuels. The products discussed are quite diverse. Industrial chemicals include acetic acid, acetone, ethanol, and butanol. It was interesting to note that the majority of these sections were written from the academic community, since, as the editor noted in the introduction, previous biological routes to these products were supplanted by the success of the petroleum based industry. The rise of petroleum prices has brought renewed interest in the biological routes. Several sections are devoted to manufacture of enzymes, the best of which discuss starch and glucose conversion. The survey of microbial polysaccharides is also noteworthy.

It is somewhat of a dilemma that the book's strong point could also be viewed as a weakness. The strong point is its comprehensiveness and scope of biotechnology. Given the enormous scope of its charter, the book is, in general, successful. By nature of its format and variety of authors, the detail, impact, and quality of the sections is uneven. There were serious omissions—such as an expanded discussion of vitamins (B12, Riboflavin, etc.) that are also products of biotechnology and important industrial commodities. There was also a missed opportunity to further expand the multidisciplinary approach. The third section in particular could have benefited from expanded discussion on the impact that molecular biology can have on enzyme specificity and yield, and that biochemical and chemical engineering can have on process economics through advances in reaction and separation technology. The large scope and volume of material also result in a high cost.

In summary, the series would make a valuable addition to an academic or industrial reference library. The wide scope of material and large number of refer-