BIOSEPARATIONS: AN ENGINEER'S PERSPECTIVE

***Bioseparations: Downstream Processing for Biotechnology*. By Paul A. Belter, E. L. Cussler, and Wei-Shou Hu. Pp. 368. ISBN 0-471-84737-2. $35.00. (Wiley Interscience, New York, NY. 1988.)**

Those who could foresee where biotechnology was headed have been reminding us for some time that the gap between rapid advances in genetic engineering and innovations in product purification was only widening. Few academic institutions command the expertise or facilities to train students in state-of-the-art separation technologies. Research on the engineering aspects of bioseparations, moreover, hasn't gained much momentum. And even though some companies—usually because they were under intense pressure to bring a product to market—have actually made significant, specific technological advances, they tend not to publish their results. In this atmosphere, Belter et al.'s *Bioseparations: Downstream processing for Biotechnology* is an arrival that is as welcome as it is overdue.

The authors have analyzed the various downstream processing steps necessary to produce a marketable bioproduct in terms of traditional engineering unit operations—even though biological separations require more steps (a sequence of 10 is not uncommon) and special handling (so the product retains its biological activity). The unit operations fall into four sequential categories: removal of insolubles, isolation of the product from the clear "beer," purification, and polishing. This formal approach is very helpful. Thus, centrifugation of lysed cells is classed as the removal of insolubles, ultrafiltration of proeins is the isolation, chromatography is the purification, and crystalization is the final polishing step.

In Part I, on removal of insolubles, the authors cover filtration and microfiltration, centrifugation and cell disruption. They present standard filtration and centrifugation theories, with numerical examples taken from the pharmaceutical industry. Part II, on isolation, deals with extraction and adsorption. Overall, these two chapters parallel any text on unit operations—except, of course, the examples are relevant. Part III is where we find those separation techniques that are largely driven by biotechnology. The chapters dealing with elution chromatography, precipitation, ultrafiltration, and electrophoresis are appropriately written with an engineering slant, and will be useful in design and scale-up. But the authors have not dealt with the issues that are unique to biological purifications. For instance, given that the purity requirements for a therapeutic protein are extremely stringent—and may never be met simply by the routine application of techniques known to work for chemicals—it would have been helpful if the authors had included a discussion of the most modern analytical techniques for detecting minute impurities. And Part IV, on polishing—containing chapters on crystallization and drying—applies more to small molecular weight products such as antibiotics and amino acids than it does to proteins and other large molecules.

The authors include a chapter in the Appendix on the characteristics of biological material. This information, which is essential to understanding bioseparations, should have formed the basis of the *first* chapter—expanded to include more biochemistry, protein structure, and protein chemistry. The authors have omitted topics that are essential for capturing the essence of bioseparations: descriptions of fermentation and cell culture, providing the scope of separation problems; details on proteins, including classification, properties, stability, denaturation, and renaturation; and a bit of cell biology. Also missing is the sense of an integrated approach to bioseparation. Perhaps a flow sheet in the introductory chapter detailing the steps in a separation train would help.

The authors, being chemical engineers, have written this book for engineering students. It is aimed at demonstrating their own hypothesis that biochemical separation is essentially the application of chemical engineering principles to biochemical process problems. As such, all chapters attempt to deal with design, mathematical analysis, modeling, and scale-up. The engineering approach is the primary strength of the book; it could easily become a standard text in undergraduate biochemical engineering curricula. As the first book of its kind, however, *Bioseparations: Downstream Processing for Biotechnology* carries the burden of assessing not only where bioseparation technology is, but where it is going. For the latter, the book will be found wanting: it does not cover emerging technologies, and consequently will be of limited value to researchers.

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WHO OWNS PLANT GERMPLASM?

***Seeds and Sovereignty: The Use and Control of Plant Genetic Resources*. Edited by Jack R. Kloppenburg, Jr. Pp. 368. ISBN 0-8223-0756. $47.50. (Duke University Press, Durham, NC: 1988).**

Seeds are big business. The companies involved appear to be orderly enterprises organized to research, produce, and sell product. But beneath this facade seethes a controversy over who owns, and who should benefit from, the genetic base (germplasm) from which most major crops are derived or improved. In this book, 20 experts from several nations, representing both the natural and social sciences, consider the historical background of germplasm ownership and exploitation.

This book is timely and appropriate. The global seed industry is substantially consolidated. Many companies recognize the potential for adding value to seed through advanced breeding methods and plant biotechnology. But while the methods to manipulate genes have been perfected in the industrialized countries, the sources of many genes for transfer are wild plants in the Third World. Thus germplasm from the Third World returns to it in the form of high-priced seed.

Since 1980, Third World politicians and scientists have expressed a growing unease with germplasm exchange. This disaffection culminated in political action—the Food and Ag-