PREFACE

Advances in biotechnology, novel materials, and advanced engineering approaches continue to be translated into industrial bioprocesses, bringing new products to market at a pace significantly faster than in most other industries. Biotechnology is revolutionizing medicine, environmental monitoring and remediation, consumer products, food production, agriculture, and forestry. These applications are all the result of biotechnology on an industrial scale. This *Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology* (*EIB*) is a unique resource representing over 30 years of evolution of biotechnology techniques, which are the foundation for the biomanufacturing industry.

The *EIB* is a global compilation of knowledge from the many disciplines used in industrial practice. Contributions are included from 693 authors from 37 countries, many of whom are practicing industry or regulatory professionals. Contributions include methods for gene and protein engineering, plant biology, cell biology, the genetics of industrially used microorganisms, cell lines, development of transgenic plants, and engineered enzymes. In addition, methods are included for biochemical reactor engineering, manufacture of novel nanostructured biomaterials, bioseparation, guides for biosafety, and regulatory compliance. The genomes of over 1,000 organisms have now been sequenced and examples are included of how genomic data is used in strain engineering and identification. One third of the contributions cover GMP biopharmaceutical manufacturing, use of disposables in bioprocessing, regulatory guides, novel bioreactors, protein stability and formulation, novel separations, and nanostructured biomaterials.

Prior to the advent of recombinant DNA and monoclonal antibody technologies, the literature of industrial microbiology, tissue culture (later known as cell culture), bioseparation, and biochemical engineering were rarely combined. Examples are *Materials and Methods in Fermentation* by Solomons (Academic Press, 1969) and *Biochemical Reactors* by Atkinson (Pion Limited, 1974). The combination of biology, molecular biology, genetics, engineering, and product-focused industrial information into a single work can be traced to *Biochemical Engineering* by Aiba, Humphrey, and Millis (Academic Press, 1964, second edition 1973), followed by *Microbial Technology* by Peppler (Reinhold, 1967) and its expanded second edition by Peppler and Perlman (Academic Press, 1979). In 1975 Pirt published his very useful *Principles of Microbe and Cell Cultivation* (John Wiley & Sons), followed by the classic *Fermentation and Enzyme Technology* by Wang, Cooney, Demain, Dunnill, Humphrey, and Lilly (John Wiley, 1979). Perlman suggested that more microbiology be included in engineering texts, which led to the classic text *Biochemical Engineering* by Bailey and Ollis (McGraw-Hill, 1977, second edition 1986). This latter edition included microbe and cell biology, enzyme kinetics, metabolic stoichiometry, energetics, and molecular genetics as parts of an engineering text. In the last 15 years many useful cross-disciplinary biochemical engineering texts have been published that include biology. Bioprocess engineers now receive formal training in biology, molecular biology, and genetics. Biology also has moved toward quantitative approaches more common in engineering such as modeling of cell populations, simulation of metabolic pathways as reaction networks, quantitative genetics, mathematical descriptions of living cells as "omics," and bioinformatics methods to design and predict the properties of new enzymes, pathways, cells, and tissues.

Since the late 1980s, the cross-disciplinary information needed by industry to train new scientists, engineers, and business leaders to commercialize biotechnology has exploded. Professionals entering this industry had to assimilate fundamental and process-focused information from a wide range of biological and engineering literature, patents, monographs, short courses, and government regulatory documents. One efficient introduction to this vast knowledge was the Wiley Biotechnology Encyclopedias comprising the *Encyclopedia of Molecular Biology and Medicine;* the *Encyclopedia of Bioprocess Technology: Fermentation, Biocatalysis and Bioseparation;* the *Encyclopedia of Cell Technology;* and the *Encyclopedia of Ethical, Legal, and Policy Issues in Biotechnology* (Wiley-Interscience, 1999, available online 2003). These works organized broadly useful information in an A-to-Z format with easily searchable key words. Selected contributions from the *Encyclopedia of Bioprocess Technology* and the *Encyclopedia of Cell Technology* are included in the *EIB*. With its significantly expanded scope, the *EIB* will be useful to legal, intellectual property, environmental, education, engineering, materials science, and government regulatory and policy professionals as a guide to current industrial practice as well as the primary literature.

The future growth of biotechnology as an industry for the benefit of humanity and sustaining our environment depends upon rapid access to biology and engineering knowledge, professionals trained in multiple disciplines, and the willingness to maintain an industry-standard source of high-quality information. To be of benefit to industry, the *EIB* must be continually updated by subject matter experts to ensure that the content stays current with the rapid pace of new knowledge applied to biomanufacturing processes.

An important cautionary note—application of knowledge requires responsibility. To the vast majority of people, the extraordinary advances in biotechnology are only observed when this knowledge is used to produce commercial products. For this reason, industrialization of biotechnology carries enormous ethical, social, and environmental responsibilities. Numerous sections of the *EIB* address these critical ethical issues.

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