

Preface

A LOOK BACK

This issue of *Applied Biochemistry and Biotechnology* consists of papers presented at Frontiers in Bioprocessing III, an international symposium, the third in a series by that title. The major purpose of the Frontiers in Bioprocessing Conferences is the assembly of eminent workers in a wide range of fields specified by the particular conference. The Conferences have been held in Boulder, Colorado at three-year intervals. The discipline of bioprocessing has evolved in many ways since the first conference in 1987. All speakers are invited, and all registrants are invited to present posters. Most of the invited papers and some posters appear in the proceedings.

The first Frontiers in Bioprocessing Conference (1) included in its goals the assembly of molecular biologists and chemical engineers to learn from one another. The budding biotechnology industry was weathering a storm of arrivals and departures, but the first major success had just established a foothold, and, indeed, the opening session on process integrations included a presentation of the Eli Lilly human insulin process (2) as one of the highlights of the conference. Entrepreneurs, molecular biologists, and chemical engineers who had not met one another previously shared their most recent triumphs and greatly enhanced the science-engineering communication pathway. Engineers had an opportunity to recognize the properties of bioproducts, and scientists had an opportunity to recognize the engineering view of the economies of scale. More significantly, science and technology from the then "frontiers" were brought together. The net result was the establishment of permanent ties among participants who needed one another and vigorous discussions of novel technical hypotheses. The areas emphasized were process integration, molecular biology, upstream processing (including sensor technology and cell culture), and downstream processing, especially including processes not yet enjoying industrial applications.

The first conference set the tone for the second, and molecular methods were featured including in vitro protein synthesis (3), chemical synthesis of a polypeptide enzyme (4), and enantioselective syntheses (5)—in the name of protein and enzyme engineering. Cell culture methods included the use of cells from higher plants (6), as in the first Conference (7)—a prediction of things to come. In 1990 functionalized membranes were under intense commercialization and held center-stage position at Frontiers in Bioprocessing II (8,9). A recognizable trend during this period was an increasing participation of engineers in scientific research basic to biotechnology (10,11) and an increasing ability of engineers to communicate with biologists.

In summarizing the second Conference, Alan S. Michaels (12) pointed out that in 1990 the emphasis was still on high-purity, high-value bioproducts produced and purified at modest scale. For this to change,

the cost of production must be brought under control and not be assumed a negligible part of the cost of a product relative to the cost of its development and its potential market value. Michaels went on to say:

In due course, however, the focus of industrial biotechnology is certain to shift to (or broaden to cover) bioproducts intended for use as veterinary therapeutics and growth regulators, pesticides and plant growth regulators, and food-components and -additives. For such products, both the scale of production and the market structure will demand the development of high-tonnage, cost-effective manufacturing procedures which will not only meet the required quality and purity standards, but can meet process competition in the market. Few of the bioprocessing techniques now in use, or contemplated for use, in the production of human therapeutic biologicals are likely to satisfy these requirements. How will we respond to this challenge? It is my hope and expectation that, now that the log-jam of interdisciplinary communication between life scientist and engineer has been broken, together we can eagerly and effectively attack these new bioprocess problems, and speedily solve them.

Three short years later it became highly apparent that larger-scale applications of biotechnology were emerging, and this prophesy was being fulfilled. Using plant systems to make chemicals in large quantities, using genetically engineered microorganisms in environmental remediation and bioprocessing of coal were the ascendant topics at *Frontiers in Bioprocessing III*, and research in human therapeutic biologicals had taken a path not predicted as recently as 1990: RNA-based therapeutics and cell-based systems for surrogate human organ functions. No longer did the *Frontiers in Bioprocessing Conference* serve to enhance communication between engineers and biologists but it served to collect the fruits of their ongoing emerging collaborations.

THE SUBJECTS ADDRESSED

For the reasons just mentioned, the subjects addressed by the invited participants in *Frontiers in Bioprocessing III* were: oligonucleotide technology and applications (including scale-up of production—a very difficult problem), differentiating animal- cell bioreactors as surrogate organs (an activity of engineers), plants as sources of biochemicals, emerging downstream processing techniques (with engineers using molecular genetics methods), microbial systems for large-scale bioremediation, and bioprocessing of coal. In this version of the Conference, biologists and engineers were already blended into one mind-set, so the interdisciplinary communications were between unrelated areas of bioprocessing applications but not just between engineers and biologists. Those interested in human biotherapeutics, for example, had an opportunity to view corners of biotechnology (environmental applications) of which they were quite unaware. Likewise, environmental engineers were exposed to medical applications of biotechnology, and each had ideas to contribute to the other. Nucleotide chemists and coal chemists had an opportunity to

mingle. Unfortunately it is impossible to capture in the pages of a journal the personal and intellectual satisfaction derived from highly interdisciplinary interactions. Readers of the pages below can only appreciate the variety of the disciplines represented and the intense progress being made in them.

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