

FOREWORD

A symposium on biotechnology was featured at the 95th annual meeting of the Ohio Academy of Science, which met at the University of Toledo on 25 April 1986 (W. R. Konneker, presiding). One session discussed economic implications of the emerging biotechnologies and another session featured the role of education and the scope of the educational challenges. The implicit connection between the themes of the two sessions is the interaction between the production and educational systems of society. New technologies are new information of a special kind—knowledge of new ways to combine resources for the objective of production. Application of the biotechnologies requires innovations in processes and products that are commercially viable. New products gain market acceptance because they fill a market niche; new processes gain market acceptance because they are more efficient. In both cases the benefits to mankind of the new biotechnologies will be through the agencies of the economic system.

The meeting at Toledo came at a time when the restructuring of Ohio industries, especially the steel and motor vehicle industries, was at a climax. Plant shutdowns and layoffs were everyday occurrences, but there was a general realization among the leadership of Ohio—political, business, and academic—that the only reasonable course to chart for Ohio's economic growth was one embracing new, more efficient technologies in order to compete on a global scale. The biotechnologies will ultimately influence all of the great industries and, in the long run, will significantly alter production methods in crop production, animal husbandry, and chemical conversion. Many of the scientists among the membership of the Academy are biologists, and the biotechnology theme combined the social needs of Ohio with the depth of the scientific resources of the State, which are considerable.

Three concentrations of scientific talent for the advance of biotechnologies are in Ohio. These are the Ohio Agricultural and Research Center at Wooster, which is a part of The Ohio State University; the Edison Animal Biotechnology Center at Athens, which is part of Ohio University; and Case-Western Reserve University in Cleveland. Of course, work in this field is also taking place at other universities in Ohio and at the great hospital complexes, but at the three locations cited above, groups of scientists are working daily on various facets of the emerging biotechnologies. Each of these groups is represented by articles contributed to this special edition of *The Ohio Journal of Science*.

Because the symposium focused on the economic and educational aspects of biotechnology, some of the contributions by scientists are reflections and observations from these perspectives rather than from their customary role as laboratory scientists. This permits a uniquely valuable contribution by these scientists, which is rare in scientific journals. The professional economists and educators are in a more familiar milieu. The contributions from industry members provide balance and breadth, because innovations are the mainspring of human progress and require the commercialization of the new technologies.

Several of the articles selected were originally cast as oral presentations, and an editorial decision was made to leave them in lecture form. The decision was a difficult one, but the vitality of exposition was maintained. To recast them would have artificially changed them with dubious benefit. All of

the contributors have established credentials and are therefore qualified to offer opinions on their own authority.

The themes of the symposium were prospective: biotechnologies are just emerging; the innovations are just beginning; changes in processes are still tentative. The considered comments and contributions of the authors are an important milestone on the current prospectus for biotechnology.

ORGANIZATION OF PAPERS

This symposium issue includes one example of scientific research and one survey of current knowledge. Most of the other papers discuss some aspect of the transition from the research laboratory to product commercialization.

C. Cullis begins the issue with a wide-ranging survey of current research in plant biotechnology. In the second paper, C. P. Hodgson provides the insights of a working scientist on the training of research staff and proposed federal regulations. He notes the potential benefits and drawbacks from a collaboration between universities and business firms.

In the third paper T. E. Wagner proposes that such collaborations are essential for regional growth. He argues that university research projects in animal biotechnology should emphasize product development that can benefit regional farmers.

The two papers that follow discuss the training of research scientists in several fields related to biotechnology. A. W. Stegles describes his own highly successful methods for teaching molecular biology to medical students; D. N. Foster has contributed a provocative example of the type of pure research that can be performed using top-flight undergraduate students.

The transition from laboratory to market place can be difficult. Many new biotechnology firms, which have invested heavily in research, have not developed commercial products. Stock market values are based on the promise of new technology. R. W. Janson and V. K. Pavlakovic have presented a method to evaluate early-entry biotechnology firms. The business community's awareness and familiarity with new technology will play a major role in its spread. G. F. Barton of the Monsanto Company has surveyed business attitudes in Ohio and South Carolina on the general subject of biotechnology.

Another unknown factor for new products and processes is the cost of regulation. Most of the delays in commercialization result from public concern over testing of new products in the environment. H. J. Howland, an attorney, describes the new regulatory scheme for biotechnology products and tracks a few products through the regulatory network. H. A. Schneiderman of Monsanto Company's research and development department predicts that new bioengineering techniques will boost food production and reduce disease dramatically over the next 20 years. In the long run, he foresees energy production from biomass.

The final paper in the collection is by an economic historian, M. G. Giesbrecht, who reminds us that technological change, no matter how rapid, should also be viewed as a global historical process and that technology makes a unique, non-material contribution to production. His comments are reflective and are appropriate as an afterword.

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