Introduction to the Proceedings of the Seventeenth Symposium on Biotechnology for Fuels and Chemicals

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The application of microorganisms to produce valuable products dates from antiquity with the fermentation of various plant materials to alcoholic beverages. These techniques were extended to manufacture industrial-based products, but chemical routes to produce such commodities from fossil sources displaced many of these biologically based technologies following World War II. With concerns about oil shortages, high petroleum prices, and air quality, fermentation processes again became the basis for the emergence of major industries for production of ethanol from starch crops in the United States and from cane sugar in Brazil in the early 1980s. Mounting environmental issues of waste disposal, the potential for global climate change, and pollution prevention have driven the need for development of new biological processes to produce fuels and chemicals from renewable cellulosic biomass feedstocks, such as agricultural and forestry residues, municipal wastes, and woody and herbaceous energy crops as well as existing crops, coal, carbon dioxide, and other resources. Similar technologies can also be applied to remedy environmental problems. However, widespread use of biological processes depends on achieving technical advances that make them profitable.

The vast potential of metabolic engineering coupled with modern advances in bioprocessing methods opens up a wide range of new possibilities and unprecedented uses for biotechnology in the production of fuels and chemicals that more traditional technologies could not likely achieve. Recent advances in biotechnology have reduced the estimated cost of ethanol production from cellulosic biomass to the point that it is competitive for blending with gasoline, and continued reductions in the cost of producing ethanol from cellulosic biomass will lead to its widespread use as a pure automotive fuel at a scale well beyond anything we have seen before. Such low-cost ethanol could become viable as a feedstock for ethylene synthesis, opening up a large segment of the chemical

market to biotechnology-based products. Biotechnologies are emerging for directly producing other chemicals and intermediates, such as lactic and succinic acid and polyhydroxybutyrate, that are environmentally friendly. Continued advances in biotechnology will lead to development of algae and higher plants that can economically produce oils for transformation into diesel fuel substitutes, chemicals, and materials. Biotechnology is also being applied to the removal of sulfur from petroleum, the liquefaction of coal, and the processing of waste streams.

These and numerous other applications of biotechnology to the production of fuels and chemicals and environmental cleanup, as well as yet unknown developments that will emerge in the future, will result in tremendous benefits to society. They will create new jobs, lower the dependence on oil imports, improve the trade balance, improve our air quality, cut greenhouse gas emissions, reduce the hazards of producing fuels and chemicals, and prevent pollution. They will also provide profitable enterprises that fuel our economy. Through the coordinated efforts of universities, government research laboratories, and industry, biological processes can be taken from conception to commercial uses that realize this enormous potential.

In the tradition of the annual symposium series, the Seventeenth Symposium on Biotechnology for Fuels and Chemicals continues to provide a forum for the exchange of information and ideas on advances in biotechnology that facilitates the emergence of a large-scale industry for the competitive production of fuels and chemicals. This year's program included 35 oral and 115 poster presentations covering topics in thermal, chemical, and biological processing; applied biological research; bioprocessing research; process economics and commercialization; and environmental biotechnology. Formal discussion sessions were organized on moving ethanol and ethyl tertiary butyl ether into the marketplace, biotechnology for the forest products industry, moving biodiesel into the marketplace, and trends in commercial cellulases, such as production, specifications, and cost. Coupled with various tours, the banquet, informal discussions, and a tranquil setting, the Seventeenth Symposium provided a congenial atmosphere for productive interactions among the 225 attendees from academia, industry, and government.

The Seventeenth Symposium was sponsored by the Office of Alternative Fuels and Office of Industrial Processes of the US Department of Energy (DOE); the National Renewable Energy Laboratory; Oak Ridge National Laboratory; Idaho National Engineering Laboratory; Argonne National Laboratory; A.E. Staley Manufacturing Company; Archer Daniels Midland Company; Bio-Technical Resources, L.P.; Chronopol, Inc.; Colorado Institute for Research in Biotechnology; Dow Chemical; DuPont Company; Enzyme Bio-Systems, Ltd; FermPro Manufacturing LP; Gist-brocades; Golden Technologies Company, Inc.; Grain Processing Corporation; Martin Marietta Energy Systems; National Corn Growers Association; New Energy Corporation of Indiana; Raphael Katzen Associates International, Inc.; South Point Ethanol; St. Lawrence Tech-

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Organization of the Symposium was as follows:

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3. "Proceedings of the Third Symposium on Biotechnology in Energy Production and Conservation" (1981), *Biotechnol. Bioeng. Symp.* **11.**
4. "Proceedings of the Fourth Symposium on Biotechnology in Energy Production and Conservation" (1982), *Biotechnol. Bioeng. Symp.* **12.**
5. "Proceedings of the Fifth Symposium on Biotechnology for Fuels and Chemicals" (1983), *Biotechnol. Bioeng. Symp.* **13.**
6. "Proceedings of the Sixth Symposium on Biotechnology for Fuels and Chemicals" (1984), *Biotechnol. Bioeng. Symp.* **14.**
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13. "Proceedings of the Thirteenth Symposium on Biotechnology for Fuels and Chemicals" (1992), *Appl. Biochem. Biotechnol.* **34,35.**
14. "Proceedings of the Fourteenth Symposium on Biotechnology for Fuels and Chemicals" (1993), *Appl. Biochem. Biotechnol.* **39,40.**
15. "Proceedings of the Fifteenth Symposium on Biotechnology for Fuels and Chemicals" (1994), *Appl. Biochem. Biotechnol.* **45,46.**
16. "Proceedings of the Sixteenth Symposium on Biotechnology for Fuels and Chemicals" (1995), *Appl. Biochem. Biotechnol.* **51/52.**

This symposium has been held annually since 1978. We are pleased to have the proceedings of the Seventeenth Symposium currently published in this special issue to continue the tradition of providing a record of the contributions made.

The Eighteenth Symposium is planned for May 5–9, 1996 in Gatlinburg, Tennessee. We encourage comments or discussions relevant to the format or content of that meeting.