

# **Introduction to the Proceedings of the Twenty-Seventh Symposium on Biotechnology for Fuels and Chemicals**

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The Twenty-Seventh Symposium on Biotechnology for Fuels and Chemicals was held May 1–4, 2005 in Denver, Colorado. Continuing to foster a highly interdisciplinary focus on bioprocessing, this symposium remains the preeminent forum for bringing together active participants and organizations to exchange technical information and update current trends in the development and application of biotechnology for sustainable production of fuels and chemicals. This annual symposium emphasizes advances in biotechnology to produce high-volume, low-price products from renewable resources, as well as to improve the environment. Topical foci include advanced feedstock production and processing, enzymatic and microbial biocatalysis, bioprocess research and development, opportunities in biorefineries, commercialization of biobased products, as well as other special topics.

Advances in commercialization of bioproducts continued apace this year, and the level of interest and excitement in expanding the use of renewable feedstocks continued to grow. Nonetheless, significant technological challenges must be overcome to achieve widespread commercialization of biotechnological fuels and chemicals production, particularly to move the feedstock base beyond primarily sugar crops and cereal grains (starch) to include holocellulose (cellulose and hemicellulose) from fibrous lignocellulosic plant materials.

Participants from academic, industrial, and government venues gathered to discuss the latest research breakthroughs and results in biotechnology to improve the economics of producing fuels and chemicals. The total of 459 attendees represented an all-time conference high; this is almost a 33% increase over the 2004 conference attendance in Chattanooga. Of this total, approximately 45% of attendees were from academia (about half of this, more than 21% of the total attendees, were students), 31% were from

industry, and 22% were from government. A total of 71 oral presentations (including Special Topic presentations) and 329 poster presentations were delivered. The high number of poster submissions required splitting the poster session into two evening sessions. (Conference details are posted at [http://www.eere.energy.gov/biomass/biotech\\_symposium/](http://www.eere.energy.gov/biomass/biotech_symposium/).)

Almost 35% of the attendees were international, showing the strong and building worldwide interest in this area. Nations represented included Australia, Austria, Belgium, Brazil, Canada, Central African Republic, China, Denmark, Finland, France, Gambia, Germany, Hungary, India, Indonesia, Italy, Japan, Mexico, The Netherlands, New Zealand, Portugal, South Africa, South Korea, Spain, Sweden, Thailand, Turkey, United Kingdom, and Venezuela, as well as the United States.

One of the focus areas for bioconversion of renewable resources into fuels is conversion of lignocellulose into sugars and the conversion of sugars into fuels and other products. This focus is continuing to expand toward the more encompassing concept of the integrated multiproduct biorefinery—where the production of multiple fuel, chemical, and energy products occurs at one site using a combination of biochemical and thermochemical conversion technologies. The biorefinery concept continues to grow as a unifying framework and vision, and the biorefinery theme featured prominently in many talks and presentations. However, another emerging theme was the importance of examining and optimizing the entire biorefining process rather than just its bioconversion-related elements.

The conference continued to include two Special Topics sessions devoted to discussing areas of particular interest. This year the two topics were international biofuels developments and the evolving attitudes about biomass as a sustainable feedstock for fuels, chemicals and energy production. The first Special Topic session was entitled “International Energy Agency (IEA) Task #39—Liquid Biofuels.” This session focused on recent international progress on production of liquid biofuels and was chaired by Jack Saddler of the University of British Columbia. The second Special Topic session was entitled, “‘Outside of a Small Circle of Friends’: Changing Attitudes about Biomass as a Sustainable Energy Supply,” and was chaired by John Sheehan of NREL. This session focused on the evolving perceptions within the agricultural producer and environmental and energy efficiency advocacy communities that biomass has the potential to be a large volume renewable resource for sustainable production of a variety of fuel, chemical, and energy products.

The Charles D. Scott award for Distinguished Contributions in the field of Biotechnology for Fuels and Chemicals was created to honor Symposium founder Dr. Charles D. Scott who chaired this Symposium for its first ten years. This year, the Charles D. Scott award was presented to Lee R. Lynd. Dr. Lynd is a Professor of Engineering and an Adjunct Professor of Biology at Dartmouth College, as well as a Professor Extraordinary of Microbiology at the University of Stellenbosch, South Africa. He has made many pioneering contributions to bioenergy and biomass conversion. Most impressively, his activities and accomplishments span the science, technol-

ogy and policy domains. Highlights include improving our fundamental understanding of microbial cellulose utilization, advancing the design and evaluation of biomass conversion processes and providing a variety of critical analyses and inputs to policy makers in support of bioenergy. An active consultant and frequently invited presenter on technical and strategic aspects of biomass energy, Dr. Lynd has twice testified before the US Senate. He recently co-led a large multi-institutional project entitled *The Role of Biomass in America's Energy Future*. The author of more than sixty peer-reviewed papers and several comprehensive reviews, and the holder of five patents, the field of biotechnology for fuels and chemicals would not be the same were it not for Dr. Lynd's tireless and inspired efforts.

### Session Chairpersons

#### ***Session 1A: Feedstock Supply and Logistics***

Chairs: Peter C. Flynn, *University of Alberta, Edmonton, Alberta, Canada*  
Foster Agblevor, *Virginia Polytechnic Institute and State University, Blacksburg, VA*

#### ***Session 1B: Enzyme Catalysis and Engineering***

Chairs: Joel R. Cherry, *Novozymes, Inc., Davis, CA*  
Kevin Gray, *Diversa Corporation, San Diego, CA*

#### ***Session 2: Today's Biorefineries***

Chairs: Robert Benson, *Tembec Chemical Products Group, North Bay, Ontario, Canada*  
Paris Tsobanakis, *Cargill, Inc., Wayzata, MN*

#### ***Session 3A: Plant Biotechnology and Feedstock Genomics***

Chairs: Wilfred Vermerris, *Purdue University, West Lafayette, IN*  
Sean Simpson, *LanzaTech, Auckland, New Zealand*

#### ***Session 3B: Biomass Pretreatment and Hydrolysis***

Chairs: Richard T. Elander, *National Renewable Energy Laboratory, Golden, CO*  
Mohammed Moniruzzaman, *Genencor International, Beloit, WI*

#### ***Session 4: Industrial Biobased Products***

Chairs: Ray Miller, *E. I. DuPont de Nemours and Co., Inc., Wilmington, DE*  
Matt Tobin, *Codexis, Redwood City, CA*

#### ***Session 5: Microbial Catalysis and Metabolic Engineering***

Chairs: Lisbeth Olsson, *BioCentrum-DTU, Technical University of Denmark, Lyngby, Denmark*  
Aristos Aristidou, *Natureworks LLC, Minnetonka, MN*

#### ***Session 6: Bioprocess Research and Development***

Chairs: Michael R. Ladisch, *Purdue University, West Lafayette, IN*  
Peter Yu, *Hong Kong Polytechnic University, Hong Kong, P. R. China*

### Organizing Committee

Jim McMillan, Conference Chair, *National Renewable Energy Laboratory, Golden, CO*  
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Guido Zacchi, *Lund University, Lund, Sweden*  
Gisella Zanin, *State University of Maringa, Maringa, PR, Brazil*

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### Other Proceedings in this Series

1. "Proceedings of the First Symposium on Biotechnology in Energy Production and Conservation" (1978), *Biotechnol. Bioeng. Symp.* **8**.
2. "Proceedings of the Second Symposium on Biotechnology in Energy Production and Conservation" (1980), *Biotechnol. Bioeng. Symp.* **10**.
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**.
7. "Proceedings of the Seventh Symposium on Biotechnology for Fuels and Chemicals" (1985), *Biotechnol. Bioeng. Symp.* **15**.
8. "Proceedings of the Eighth Symposium on Biotechnology for Fuels and Chemicals" (1986), *Biotechnol. Bioeng. Symp.* **17**.
9. "Proceedings of the Ninth Symposium on Biotechnology for Fuels and Chemicals" (1988), *Appl. Biochem. Biotechnol.* **17,18**.
10. "Proceedings of the Tenth Symposium on Biotechnology for Fuels and Chemicals" (1989), *Appl. Biochem. Biotechnol.* **20,21**.
11. "Proceedings of the Eleventh Symposium on Biotechnology for Fuels and Chemicals" (1990), *Appl. Biochem. Biotechnol.* **24,25**.
12. "Proceedings of the Twelfth Symposium on Biotechnology for Fuels and Chemicals" (1991), *Appl. Biochem. Biotechnol.* **28,29**.
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**.
17. "Proceedings of the Seventeenth Symposium on Biotechnology for Fuels and Chemicals" (1996), *Appl. Biochem. Biotechnol.* **57,58**.
18. "Proceedings of the Eighteenth Symposium on Biotechnology for Fuels and Chemicals" (1997), *Appl. Biochem. Biotechnol.* **63-65**.
19. "Proceedings of the Nineteenth Symposium on Biotechnology for Fuels and Chemicals" (1998), *Appl. Biochem. Biotechnol.* **70-72**.

20. "Proceedings of the Twentieth Symposium on Biotechnology for Fuels and Chemicals" (1999), *Appl. Biochem. Biotechnol.* **77–79.**
21. "Proceedings of the Twenty-First Symposium on Biotechnology for Fuels and Chemicals" (2000), *Appl. Biochem. Biotechnol.* **84–86.**
22. "Proceedings of the Twenty-Second Symposium on Biotechnology for Fuels and Chemicals" (2001), *Appl. Biochem. Biotechnol.* **91–93.**
23. "Proceedings of the Twenty-Third Symposium on Biotechnology for Fuels and Chemicals" (2002), *Appl. Biochem. Biotechnol.* **98–100.**
24. "Proceedings of the Twenty-Fourth Symposium on Biotechnology for Fuels and Chemicals" (2003), *Appl. Biochem. Biotechnol.* **105–108.**
25. "Proceedings of the Twenty-Fifth Symposium on Biotechnology for Fuels and Chemicals" (2004), *Appl. Biochem. Biotechnol.* **113–116.**
26. "Proceedings of the Twenty-Sixth Symposium on Biotechnology for Fuels and Chemicals" (2005), *Appl. Biochem. Biotechnol.* **121–124.**

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

The Twenty-Eighth Symposium will be April 30–May 3, 2006 in Nashville, Tennessee. More information on the 27<sup>th</sup> and 28<sup>th</sup> Symposia is available at the following websites: [[http://www.eere.energy.gov/biomass/biotech\\_symposium/](http://www.eere.energy.gov/biomass/biotech_symposium/)] and [<http://www.simhq.org/html/meetings/>]. We encourage comments or discussions relevant to the format or content of the meeting.