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Session 5

Emerging Topics in Industrial Biotechnology

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Conversion of cellulosic materials and sugars is but one area in which biotechnology can contribute to the production of fuels and chemicals. Emerging areas of research hold great promise for utilizing a wider array of potential substrates for fuel and chemical production as well as complementing conventional catalysis in fuel and chemical processing. The papers presented at the Eighteenth Symposium on Biotechnology for Fuels and Chemicals address several areas in which emerging technologies will impact the future of bioprocessing.

Advancements in our fundamental understanding of photosynthetic pathways have led to the discovery of algal mutants that lack one of the two photosystems previously thought necessary for conversion of light into chemical energy. The discovery of photosynthetic conversion using only one photosystem has the potential to double the thermodynamic conversion efficiency of solar energy into stored chemical energy. Developments in the area of reactor design for photoautotrophs enable higher cell densities and a higher frequency of light–dark cycles needed for greater light utilization and hence more efficient photoconversion processes.

Synthesis gas (CO, H_2 and CO_2) represents a widely available and more easily handled substrate for chemical and fuel production than raw biomass. Gasification of biomass, waste paper, and coal can provide this substrate without pretreatment and digestion. Recent research has developed processes for the conversion of synthesis gas into acetic acid and ethanol and has demonstrated that sulfate-reducing bacteria can utilize synthesis gas as carbon and energy sources; an alternative to sugars and organic acids. Advancements in reactor design for gaseous substrates are leading to reactors better able to deliver sparingly soluble substrates to the biocatalyst.

Advances in biocatalyst research and development are enabling the use of enzymes in increasingly hostile environments and promise to broaden the spectrum of chemical processes in which biotechnology may be utilized. Native phosphotriesterases have been demonstrated to be capable of transesterification and optical resolution of racemic alcohol, phosphoric acids in a variety of organic solvents. Hyperthermophilic hydrogenase has shown to be capable of performing its native biocatalytic function after it was chemically modified so as to be soluble and active in neat toluene, an environment in which unmodified enzymes are both insoluble and inactive.

Finally, novel electric field bioreactors are being developed to efficiently contact a biocatalyst-containing aqueous phase with organic substrates. These reactors create tremendous surface area between the two phases by focusing electrically induced shear forces at liquid/liquid interfaces rather than by supplying energy to the entire bulk solution as is done in impeller-based reactors. Such systems are expected to find utility in a number of biological processes including biodesulfurization and upgrading of crude oil.