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Steps toward the Establishment of Symbiotic Relationships between Algae and Nitrogen-Fixing Bacteria for Sustainable Biofuels

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Nitrogen and phosphorus nutrient requirements are linked directly to biomass yields. Next generation biofuel crops such as algae promise higher yields of biomass and plant oil versus current conventional agricultural crops. However, increased yields for algae will come at the cost of increased nutrient requirements. Studies in our laboratory are focused on establishing mutualistic relationships between a nitrogen-fixing bacterium and specific target algae species. Recent progress has established several routes to improving nitrogen product yields from the nitrogen-fixing bacteria. In model symbiotic systems between plants such as legumes and nitrogen-fixing bacteria, the plant supports the growth of the bacterium by providing an adequate supply of reduced carbon to sustain the growth of the nitrogen-fixing heterotroph. Many species of algae are also known to produce various quantities of extracellular carbon, which should provide a first step toward the establishment of a mutualistic relationship between the algae and the nitrogen-fixing bacterium.

In this presentation, we will summarize and describe approaches that have been taken to enhance nitrogen production from our model nitrogen-fixing bacterium, *Azotobacter vinelandii*. Progress has been made using three different approaches; by converting the metabolite urea into a terminal product, by identifying a specific transporter that results in losses of nitrogen compounds to the extracellular space, and by deregulating nitrogen fixation by disrupting the regulatory apparatus for nitrogenase. Product yields based upon quantities of reduced carbon species as it related to the yields of algae that are possible will also be presented. These results will be discussed in terms of current yields of reduced carbon species from target algae strains and efforts to increase those levels through various approaches to modify the algae.

Keywords: biofertilizer; Azotobacter; Chlorella; nitrogen; algae