Center for Advanced Biofuel Systems (CABS)
EFRC Director: Jan Jaworski
Lead Institution: Donald Danforth Plant Science Center

Mission Statement: *To generate the fundamental knowledge required to increase the efficiency of photosynthesis and production of energy-rich molecules in plants.*

Our strategy is to identify kinetic and thermodynamic constraints in photosynthetic and lipid metabolism that limit the accumulation of biomass and oil in algae and oil seed plants. To relieve these metabolic constraints, we will develop integrated and optimized metabolic flux networks that increase the efficiency of solar energy conversion into oils and other biofuel components. This will be achieved by: 1) employing novel protein catalysts that increase the thermodynamic and kinetic efficiencies of photosynthesis and oil production, 2) engineering metabolic networks to enhance acetyl-CoA production and channeling towards neutral lipid synthesis, and 3) engineering new metabolic networks for the production of novel hydrocarbons required to meet commercial fuel standards. These strategies will be informed by comprehensive metabolic flux analyses of select algal and oil seed plants. Using strategies informed by computational models we will develop engineered organisms with enhanced biofuel production. What distinguishes our approach from many others is that we integrate all aspects of metabolism, from energy conversion in photosynthesis through end product production.

The technologies we will employ to address our objectives include:

1) Development of analytical and computation tools and metabolic flux models to direct engineering strategies to enhance biofuel production. Drs. Hicks, Schachar-Hill and Gang will work coordinately with each of the other co-PIs to develop these tools and models.

2) Development and introduction of catalytically enhanced or multi-functional enzyme complexes to increase the thermodynamic and kinetic efficiencies of biofuel production, including assembly of novel macromolecular catalytic complexes that reduce diffusion or enhance rate-limiting processes to increase metabolic flux. Drs. Sayre, Kutchan, and Jaworski will develop new enzyme complexes to enhance and direct flux in existing networks as well as introduce novel metabolic pathways to channel reducing equivalents generated from the photosynthetic light reactions through the Calvin cycle to enhance oil and hydrocarbon production.

3) Identification and manipulation of metabolic and/or transcriptional control elements that regulate the expression of targeted metabolic pathways focusing on the central role of acetyl-CoA in oil production. Dr. Wang will characterize and manipulate transcription factors involved in oil accumulation.

4) Generation of short- and medium-chain fatty acids and novel biofuel products (aromatic hydrocarbons) in algae and plants to meet fuel standards (e.g. JP8). Drs. Cahoon, Jaworski, Kutchan, Wang, and Sayre will work coordinately to manipulate metabolic flux channeling to increase the yields of biofuel products.

5) Dr. Terry Woodford-Thomas directs our outreach and educational efforts to inform the public about the challenges facing sustainable energy production and the efforts of CABS in meeting those challenges.

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