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Microbial Genomics for Biofuels and Co-products from Biorefining Processes

Status	Approved
Competition	Applied Genomics in Bioproducts or Crops
Sector	Environment
Genome Centre	Genome Prairie
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Project Description

As the world faces the reality of peak oil, serious efforts are being made to develop renewable energy sources that can displace our dependence on fossil fuels. One promising alternative fuel source is biological production (biofuels), in which fuels such as ethanol are produced from a wide variety of agricultural feed stocks. Current production of ethanol involves microbial fermentation of the sugars derived from sugarcane (in Brazil) or the starch from grain (predominantly corn in the US and eastern Canada, and wheat in the prairie provinces of Canada), followed by distillation of the ethanol from the fermentation broths. However, the long-term prospects of grain-based ethanol production is in question because the cost of the feed stocks makes up a large fraction of the total costs of production, and the use of food grains has very negative implications for food prices. Thus, abundant, low-cost feed stocks from other sources are essential for the commercial viability of biofuel production.

Sources of cellulose-containing biomass (ligno-cellulosics) are a potential feed stock for synthesis of fuels, and are typically waste products from forestry (e.g., wood chips) or agricultural (e.g., straw from wheat, flax and hemp) sources. However, processes that produce only ethanol from ligno-cellulosics are not economical. One way to overcome this limitation is to co-synthesize high-value products, such as lignin for resins and adhesives, along with the production of biofuels and plastics from cellulose.

The focus of our research is on the bacteria that accomplish the conversion of the ligno-cellulosics to ethanol, hydrogen, and plastics. We aim to increase the economic potential of the refining processes by developing well-characterized cultures of bacteria that can carry out these industrially important specific enzymatic reactions. This requires detailed understanding of both the genes (and their function) and metabolism of bacteria that use cellulose to make fuels and other products.

We will carry out a full genomic characterization of known and new bacteria that are selected for their ability to contribute to a variety of metabolic processes. On the basis of this information we will produce metabolically engineered bacteria with enhanced fuel and co-product synthesis characteristics. We will combine appropriate bacterial strains to create communities (or "consortia") of microorganisms for industrial application. The aim is to enable biorefineries to generate products (ethanol, hydrogen, and co-products) from relatively low-cost feed stocks of ligno-cellulosics, thus increasing their economic-viability. The goal is to help establish Canada as a leader in the production of biofuels and bioplastics.