# Genes and Gene Clusters That Enable Degradation of Recalcitrant Biological Materials

TECHNOLOGY CASE
**1425**


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***Introduction***

For several decades the United States has sought to lower its reliance on foreign oil, and at the same time has increased efforts to minimize greenhouse gas emissions. Biomass is a renewable resource that has shown promise to replace petroleum-based fuels, while reducing GHG emissions. However, the cost of biomass-based fuels historically has not been competitive relative to oil or other energy resources. Specifically, the biochemical conversion step in which plant sugar is turned into fuel has been a primary bottleneck. A key challenge in converting biomass into fuels is that a plant's cell walls have built up a natural protection (or recalcitrance) to microbes and enzymes. A second hurdle is that biomass contains many different cell components, which mean that fermentation cannot be achieved by a single naturally occurring microorganism or by a mixture of microorganisms or enzymes. As result, the transformation of cellulosic material into ethanol has been very cost-prohibitive given the amount of heat, enzymes, or bacteria needed for conversion.

***Summary***


University of Georgia researchers have has discovered the identity of a group of genes that enable a microorganism to convert untreated woody plant biomass, such as poplar wood chips, to soluble materials that can be used by the same organism or by another to produce biofuels, such as hydrogen and ethanol. The discovery was made from an analysis of the genomes of two very closely related microorganisms *Anaerocellum thermophilum* and *Caldicellulosiruptor saccharolyticus*, only one of which, *Anaerocellum thermophilum*, is able to grow on unprocessed woody plant biomass. The genes that confer this property to *Anaerocellum thermophilum* are termed PBU for plant biomass utilization. Many of the PBU genes are present in *Anaerocellum thermophilum* as gene clusters.

The invention seeks to produce microorganisms that are more capable of breaking down the biomass material. The improvement is achieved through genetically modified organisms that leverage genes from microorganisms, including *Anaerocellum thermophilum*; that have advantageous characteristics with respect to wood biomass. This special gene cluster would enable microorganisms across a wide spectrum of properties, such as temperature tolerance, to have improved effectiveness and efficiency for converting biomass into fuel. Furthermore, the invention would also eliminate the need for pretreatment, which is step prior to fermentation.


***Advantages and Some Potential Applications***

- Will allow any organism to utilize/convert unprocessed biomass
- Conversions would be achieved by metabolically-engineered microbes whose catalytic prowess is fine-tuned to a particular type of biomass
- Genes would be utilized by various organisms that grow throughout the temperature range by the appropriate genetic manipulations
- Products of biomass conversion are not limited to biofuels but extend to any polymer or commodity chemical derived from plant cell biomass

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