



# DOE Bioenergy Initiative

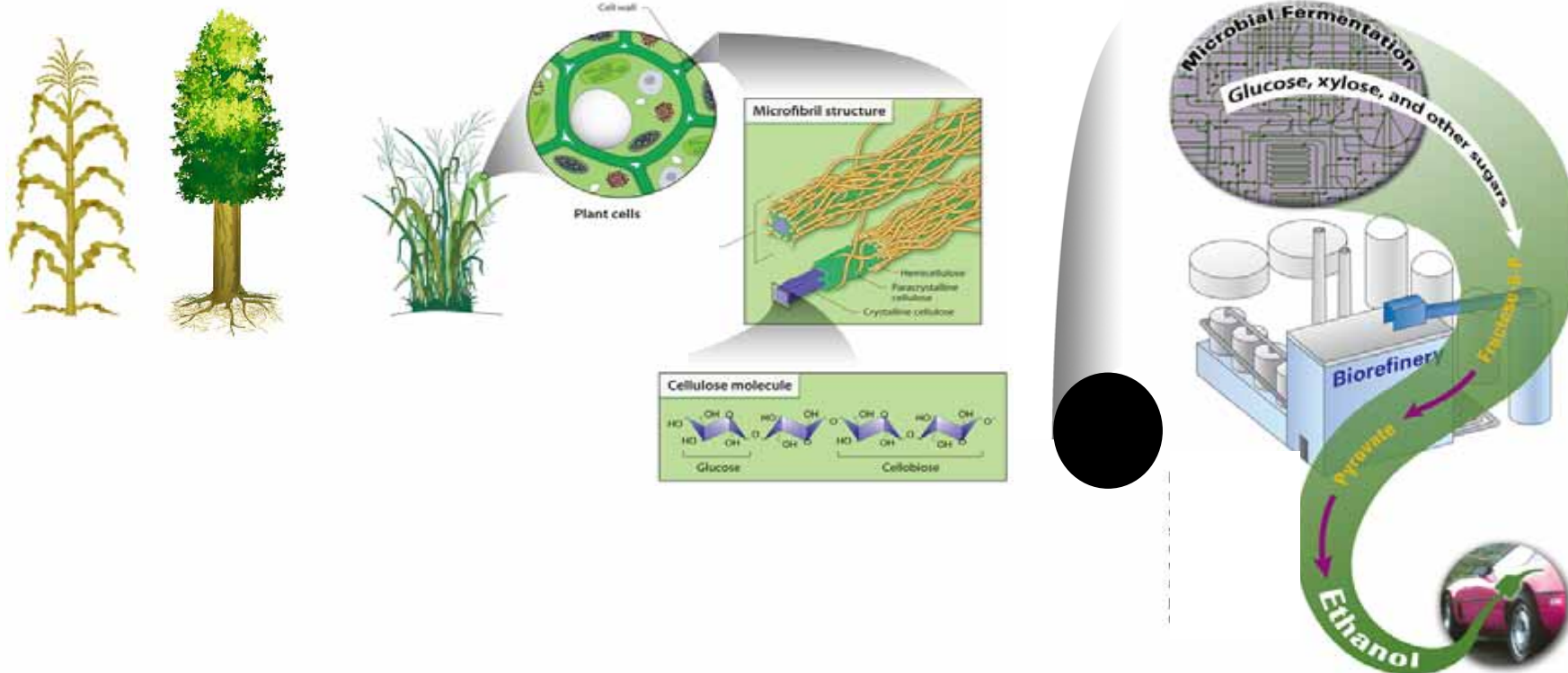
**Joint DOE/USDA Conference  
“Advancing Renewable Energy”  
St. Louis, MO**

*Dr. Raymond L. Orbach*  
**Under Secretary for Science  
U.S. Department of Energy  
October 12, 2006**

# Biomass-to-Biofuels: Cellulosic Ethanol Example

## BASIC TRANSFORMATION:

CELLULOSE → SUGARS → ETHANOL



## The Promise of Biofuels

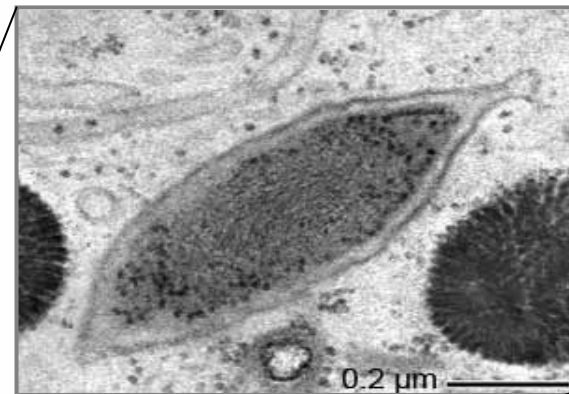
- The U.S. is capable of producing 1 billion dry tons of biomass annually (agricultural and forestry wastes, grains, and 55 million acres of perennial bioenergy crops) – enough for 60 billion gallons of ethanol per year, or ~30% of today's transportation fuel usage – and continue to meet food, feed, and export demands
- Includes specialized perennial feedstock crops: e.g., switchgrass, miscanthus, willows, hybrid poplar

# How Nature Does It: Powerful Capabilities of Microbes

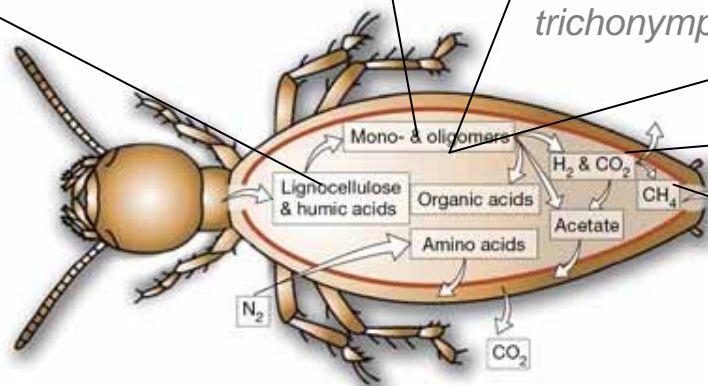
The termite's gut contains about 200 different species of bacteria, some of which are "experts" at breaking down cellulose and helping transform it into fuel in the form of hydrogen and methane.

Enzymes that break down cellulose and hemicellulose

Fermentation pathways



*"Candidatus Endomicrobium trichonymphae"*



Hydrogen production

Methane production



## How DOE Does It: DOE Bioenergy Initiative

- Funding: **\$250 million** to be provided over **five years** to establish and operate **two new Bioenergy Research Centers**
- Goals: **transformational discoveries** in **basic science** to make production of **cellulosic ethanol**, sunlight-to-fuels, and other biofuels **truly cost-effective** and **economically viable**
- Method: **advanced systems biology** research on **microbes** and **plants** - to learn to **exploit nature's own conversion methods**, plus develop a **new generation of optimized bioenergy crops**
  - Understand metabolic pathways in microbial bioconversion processes
  - Analyze plant cell wall structure and assembly
  - Fine-tune microorganisms and plants to each other
  - Pursue both microbial and bio-mimetic conversion methods

## **Harnessing the Capabilities of Genomics: Microbes**

- **Purpose: Produce “microbial machines” for energy production through re-engineering of microbes**
  - Understand metabolic pathways
  - Metabolic pathway = a series of biochemical reactions in cell, using enzymes (proteins) as catalysts, to produce products
  - Key challenge: to analyze and tweak the cellular regulatory mechanisms so as to produce an outcome tailored to bioenergy mission

## Harnessing the Capabilities of Genomics: Plants

- **Purpose: Develop a new generation of optimized “bioenergy crops”**
  - In contrast to food crops, which have been hybridized over many generations, many bioenergy crops remain in wild state
  - Work needs to be done to optimize crops for bioenergy conversion
    - Enhance crop yield
    - Reduce the inputs necessary for growth
    - Ensure sustainability
    - Optimize crops for fuel production
  - Each plant has a different lignocellulose composition to which microbes and processes will need to be tailored
  - **Regional** effort: different crops suitable to different regions based on climate, soil, and other environmental variables.



## **Joint DOE/USDA Program on Plants Genomics Research**

- This week, DOE and USDA announced \$4 million in FY2007 research grants for genomics of bioenergy feedstock crops.
- Designed to help lay groundwork for optimizing a new generation of plants for biofuels.
- Pre-applications due November 13, 2006. Final proposals due January 30, 2006.
- For more information, visit [www.grants.gov](http://www.grants.gov) and [www.doegenomestolive.org](http://www.doegenomestolive.org)





**Biofuels represent an enormous economic opportunity for U.S. agriculture, providing farmers with a major new “cash crop.” Different crops are suitable to different regions based on climate, soil, and other environmental variables.**

# DOE Bioenergy Initiative

- Provides \$250 million over five years. **Two to be awarded.**
- Open competition: universities, national labs, nonprofits, private firms, and **partnerships** of such entities invited **to compete to establish a Center**
- Private sector participation encouraged
- Innovative **multidisciplinary** approach: **no construction, rapid start-up** – utilizing latest **biotechnology advances** plus **world-class instruments in DOE complex** (high-intensity light sources, etc.)
- Timetable: applications due on February 1 - Centers established in 2008 - **Centers fully operational by 2009**