THE TERMITE GUT

Nature's Microbial Bioreactor for Digesting Wood and Making Biofuels

The microbial community within a termite's gut is one of nature's most efficient bioreactors—typically converting 95% of cellulose into simple sugars within 24 hours. More than 200 species of microbes make up this community, and together they produce a bounty of wood-busting enzymes that industry could put to work in biorefineries making ethanol from several forms of cellulosic biomass.

This diverse array of microbial capabilities that could jumpstart a new biofuel industry is the result of a codependent strategy for survival. Without wood-eating microbes, a termite would not be able to extract nutrients and energy from wood, and, without the termite to grind wood into tiny pieces and provide an oxygen-free habitat within its gut, the microbes would not be able to survive.

In addition to efficiently degrading cellulose into sugars, some termite-gut microbes are biochemically capable of generating other potential fuels such as hydrogen or methane. Hydrogen produced by one group of microbes is consumed by other gut microbes that create energy-producing by-products the termite can use. Investigations of the termite-gut community reveal a vast collection of biological pathways that may one day be put to use for multiple energy applications.

A collaboration of researchers from the Department of Energy's Joint Genome Institute (DOE JGI), the California Institute of Technology, Diversa, and the National Biodiversity Institute of Costa Rica has sequenced and analyzed microbial DNA extracted from the guts of hundreds of termites harvested from a nest in a Costa Rican rainforest. Preliminary results already have identified several novel enzymes capable of degrading cellulose into sugars, and the San Diego–based biotechnology company Diversa has used insights from this discovery to create a high-performance enzyme cocktail for processing plant biomass into biofuels.

DOE JGI researchers continue to investigate other microbial communities in the guts of insects that consume different plant materials. The goal is to understand and reconstruct a diverse range of metabolic processes that could be scaled up for industrial biofuel production. ◆

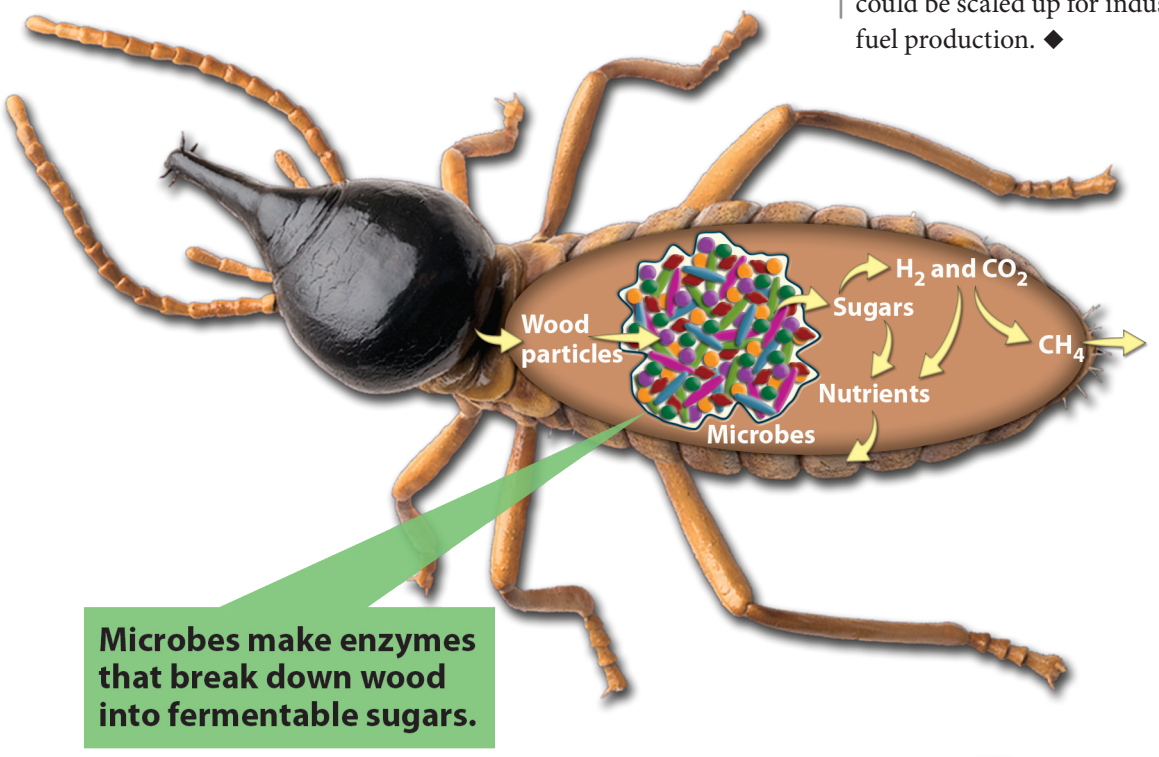

Fig. 3. Termite Microbes: A Potential Source of Enzymes to Digest Biomass for Bioenergy Production.