# Bioproduct Chemistry and Engineering Research Unit

## William J. Orts, Research Leader

The mission of the Bioproduct Chemistry and Engineering (BCE) Research Unit is to provide technical leadership in capturing the total value of agricultural resources for biofuels and biobased products. Core technologies include improved enzyme development for biomass utilization via directed molecular evolution and applied microbiology, improved grain milling, pretreatment and bioproduct isolation via optimized separation engineering, and application of advanced processing technology for converting cereal starches, straws, and under-utilized biomass sources into novel and high-performance nanocomposites. Solutions are transferred to technical partners, promoting the use of renewable agricultural resources for sustainable biofuels and bioproducts.

### Evolutionary enzyme design for improved biorefining of crops and residues

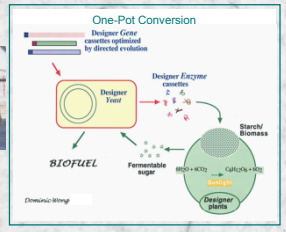
Lead scientist: Dr. Dominic Wong

Starch & biomass hydrolysis to sugars

**Improved enzymes, combinations, & delivery**

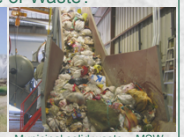
*Enzymes produced in the hydrolysis step*

Enzymes and microbes from
- Fungi
- Mushrooms
- Rumen



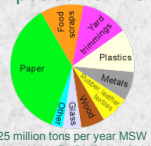

Resource or Waste?

Rice straw agricultural residue



Municipal solid waste – MSW (garbage)

Composition of MSW




425 million tons per year MSW produced in U.S. (BioCycle, 2006)

Loading autoclave with straw

CR3 Autoclaves
- Feedstock - Ag residues, MSW
- Pressurized hot water treatment
- Reduces volume
- Isolates recyclables
- Fractionates components

Clean fiber from MSW after centrifugal cleaners

Co-mingled MSW and ag-waste fibers are hydrolyzed and fermented to ethanol

Distillation of ethanol from fermentation broth

### Development of agriculturally-derived biopolymer composites for non-food applications

Lead scientist: Dr. Gregory Glenn

New materials from renewable resources

Plastics: Poly(lactic acid), Polyesters

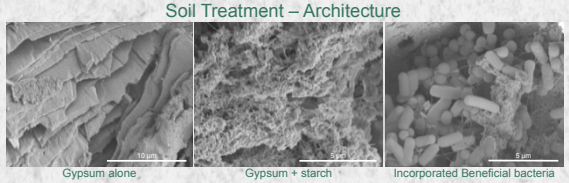
Cellulose, starch, fiber-based products

Fire logs from agricultural residues

Charcoal with biobased binders

Mixed starches

Soil Treatment – Architecture

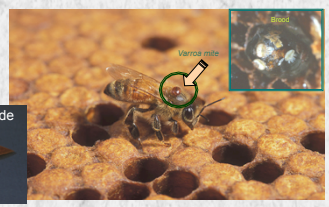



Gypsum alone | Gypsum + starch | Incorporated Beneficial bacteria

Honeybee infected with *Varroa* mite

$10-15 Billion loss to farmers in the Pacific West Area

Estimated 30-40% reduction in the honeybee population




Encapsulated natural miticide

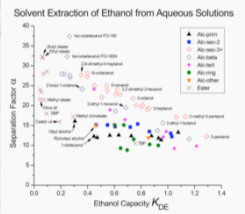
### Technologies enabling enhanced product quality, product opportunities, and energy efficiency in biorefining systems

Lead scientist: Dr. George Robertson

Biorefining
- Fractionation of grains and straws with ethanol to separate protein, starch and lignin
- Cold hydrolysis of starch

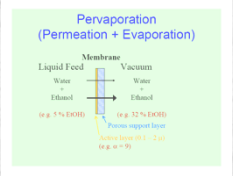
Separation technologies

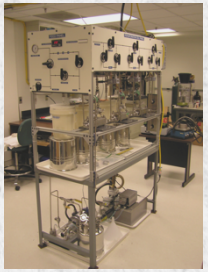
Energy efficient recovery of dilute fermentation products: Ethanol, butanol, carboxylic acids,…



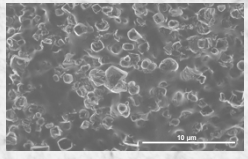

Solvent Extraction
- Screening many solvents to determine performance
- Determining factors that result in good performance
- Measuring toxicity of best solvents to the yeast that produce the biofuel

Membrane Permeation
- Finding better-performing membrane materials



Pervaporation Test Rig




Mixed-matrix membranes: highly selective adsorbent particles in a polymer matrix