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Designed Microbial Consortia for Materials Synthesis and Sustainability

U.S. ARMY RDECOM

ARL open campus

S&T Campaign: Materials Research

Tier 2 Subtopic: Biological and Bio-Inspired

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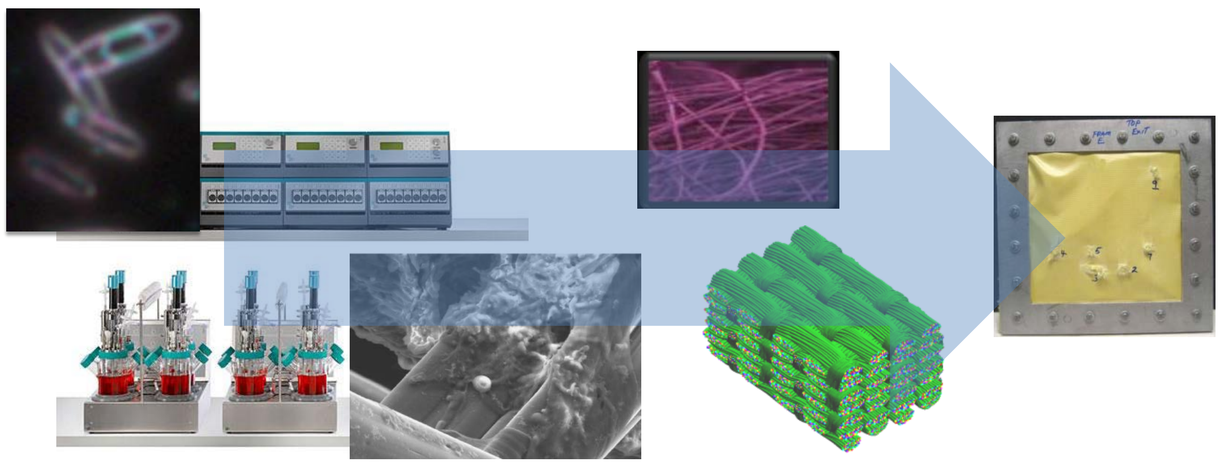
Research Objective

- Production of commodity chemicals enabling designer materials with control of desired functionality (reactivity, resiliency, biodegradability, recyclability, and reduced weight) from domestic, sustainable feedstocks
- Understand natural and designed consortia as well as cell free synthetic systems to engineer low-cost materials, low-energy waste mitigation and bio-manufacturing



Flow representing current systems biology of single organisms to consortia to designer polymer systems with advanced functionality.

Challenges

- Current methods track metabolic flux, transcription, etc. from individual species not in multi-organism systems
- Study designed consortia via bottom up assembly to understand and develop universal design principles for artificial ecology engineering
- Need advanced state-of-the-art in modeling multi-organism systems to include interactions with other organisms and ecological parameters
- Characterize genetic circuitry used in natural and artificial consortia to determine how individual species modulate responses to ecological conditions such as location in ecology, presence of other organisms, and nutrient levels
- Develop the tools for studying individual cells in ecologies to better understand how natural phenotypic heterogeneity contributes to complex multi-organism consortia and systems
- Develop a-cellular systems based upon minimal metabolic pathways to reduce system complexity

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

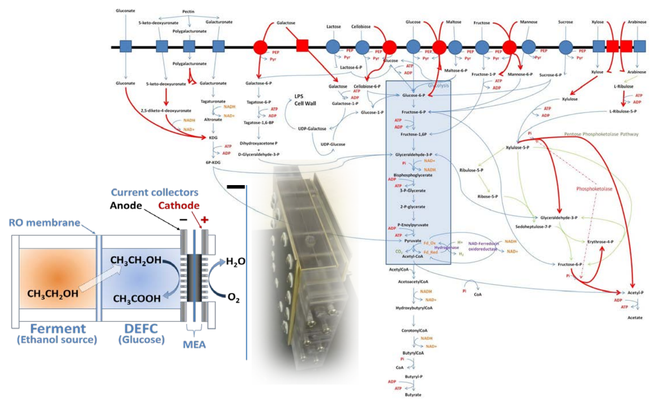
- Increased capabilities in proteomics
- Advanced chromatographic and mass spectrometric instrumentation / expertise for metabolomics

ARL Facilities and Capabilities Available to Support Collaborative Research

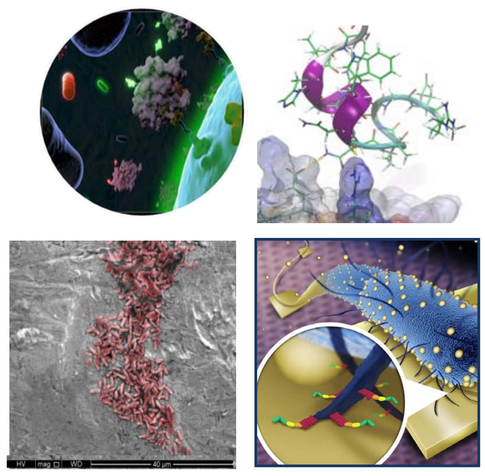
- Facilities and experience in systems biology of anaerobes for metabolic network reconstruction
- Computational Biology that incorporates Multi-Scale chemical and physical Models
- Synthetic Biology for Metabolic Investigation and Selection of Receptors for Biological and Abiological Targets
- Advanced Polymer Design, Synthesis, Processing and Characterization capabilities

Facilities at ALC and APG include anaerobic chambers, chromatography, next generation sequencing, and advanced spectroscopic and microscopic instrumentation

Metabolic Network Reconstruction



Representation of Bio-Systems and Integration Research



Representation of Bio-Materials and Bio/Bio, Bio/Abio Interface Research

"Arabinose is Metabolized via a Pentose Phosphoketolase Pathway in C. acetobutylicum ATCC 824", *J. of Ind. Microb. & Biotechnol*., **2012**, 39, 859-1867.
"Transcriptional Analysis of Differential Carbohydrate Utilization in C.acetobutylicum." *SGM Microbiology,* **2010,** 156, 3478-3491.
"A Chemically Synthesized Capture Agent Enables the Selective, Sensitive, and Robust Electrochemical Detection of Anthrax Protective Antigen", *ACS Nano*, **2013**, 7 (10), pp 9452–9460.
"Genetically Engineered Peptides for Inorganics: Study of an Unconstrained Bacterial Display Technology and Bulk Aluminum Alloy" *Adv. Mater*., **2013**, 25 (33), 4530.
"Conjugated oligoelectrolytes increase current response and organic contaminant removal in wastewater microbial fuel cells" *Energy Environ. Sci.*, **2012**, 5, 9449-9452.
"Direct Utilization of Fermentation Products in an Alcohol Fuel Cell", J. Power Sources, **2013,** 232, 34 – 41.

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