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Minisymposium August 6st

"Interactions of Nanomaterials with Complex Biological Systems"

University of Regensburg – Cornell University

3 p.m. **Julie M. Goddard**

Dept. of Food Science

Hierarchical nanocomposites for biocatalysis

3.45 p.m. **John C. March**

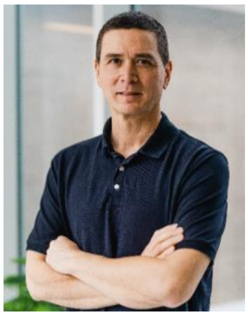
Dept. of Biological and Environmental Engineering

Cell culture systems for evaluating engineered and naturally-occurring microorganisms

4.30 p.m. **Sam R. Nugen**

Dept. of Food Science

Engineering Biorthogonal Phage-based Nanobots for Ultrasensitive, *in situ* Bacteria Detection



September 30th

The second online seminar in this series will be held on September 30th with Prof. Susan Daniel, Prof. Claudia Fischbach-Teschl, and Prof. Margaret W. Frey (Cornell University).

PROF. DR. JULIE M. GODDARD

"Hierarchical Nanocomposites for Biocatalysis"

3 p.m.

Abstract

Enzymes enable high specificity in applications such as production of value-added agricultural products, environmental remediation, and diagnostics, but are often limited by challenges in stability and recovery in these complex biological systems. Hierarchical structures, incorporating both macrostructures and nanostructures, can harness the benefits of each size regime for the stabilization of enzymes.

Here we describe two case studies. In one, lipase B from *Candida antarctica* was interfacially assembled with iron oxide nanoparticles into hierarchically ordered structures consisting of a cross-linked core of poly(dicyclopentadiene). Microparticles were characterized for performance in extreme environments (low/high pH, high temperature, solvents) which are denaturing for native lipase. Kinetic analysis revealed a significant increase in the turnover rate following immobilization. After two hours exposure to 50% acetonitrile, there was no measurable leaching of enzyme from the microparticles, while Novozym 435 lost 99.8% protein under the same conditions, suggesting robust design for use in solvent applications. Per unit protein, microparticles outperformed Novozym 435 in direct esterification and transesterification.

In another study, we demonstrate the synthesis of copper microflowers in which the enzyme b-galactosidase is incorporated with retained activity. We explore the nuance of considering both biological and non-biological system performance in the pragmatic assembly of these hierarchical biocatalytic nanocomposites. Such understanding of hierarchical biocatalytic systems can permit their application in complex biological systems to improve the safety and sustainability of food, bioprocessing, and diagnostic applications.

PROF. DR. JOHN C. MARCH

"Cell Culture Systems for evaluating engineered and naturally-occurring Microorganisms"

3.45 p.m.

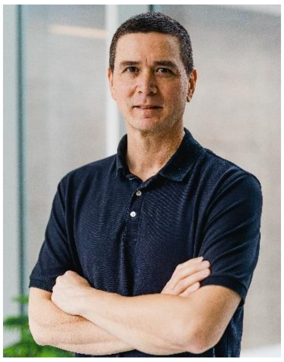
Abstract

In recent years, it has become widely accepted that *in vitro* intestinal models enable improved studies of intestinal function in an ethical and well controlled manner. Such research led to new insights into cellular growth and proliferation, drug absorption capabilities and host-microbial interactions. By using a combination of laser ablation and microfabrication techniques, we created a plastic template with accurate dimensions and concentrations of human small intestinal villi. These models along with more recent fluidic models with intestinal organoids will be discussed.

Online Symposium August 6st

"Interactions of Nanomaterials with Complex Biological Systems"

University of Regensburg – Cornell University



PROF. DR. SAM R. NUGEN

"Engineering biorthogonal Phage-based Nanobots for Ultrasensitive, *in situ* Bacteria Detection"

4.30 p.m.

Abstract

Advances in synthetic biology, nanotechnology and genetic engineering are allowing parallel advances in areas such as drug delivery and rapid diagnostics. Although our current visions of nanobots may be far off, a generation of nanobots synthesized by engineering viruses is approaching.

Such tools can be used to solve complex problems where current methods do not meet current demands. Assuring safe drinking water is crucial for minimizing the spread of waterborne illnesses. Although extremely low levels of fecal contamination in drinking water are sufficient to cause a public health risk. It remains challenging to rapidly detect *Escherichia coli*, the standard fecal indicator organism. Current methods sensitive enough to meet regulatory standards suffer from either prohibitively long incubation times or requirement of expensive, impractical equipment. Bacteriophages, tuned by billions of years of evolution to bind viable bacteria and readily engineered to produce custom proteins, are uniquely suited to bacterial detection.

We have developed a biosensor platform based on magnetized phages encoding luminescent reporter enzymes. This system utilizes bio-orthogonally functionalized phages to enable site-specific conjugation to magnetic nanoparticles. The resulting phage-based nanobots, when combined with standard, portable field equipment, allow for detection of <10 cfu/100 mL of viable *E. coli* within 7 h, faster than current standards.