NANO HIGHLIGHT
Biocatalytic Membrane Nanosystems (BMNs)

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Enzymes are proteins that catalyze a myriad of processes in living organisms, such as respiration, metabolism, gene regulation and nerve impulse transmission. Although natural processes catalyzed by enzymes are highly selective and fast, they suffer *in vivo* from serious drawbacks which limit large-scale applications of enzymes as biocatalysts for the production of pharmaceuticals. These drawbacks include slow diffusion of reactants and products across the tightly sealed cellular membrane to and from the enzymes located inside cell organelles, such as mitochondrion (Figure 1A), the difficulty of handling living cells in a large-scale process and concerns about the release of genetically engineered organisms into the environment.

The researchers on this NSF grant are developing new highly efficient *Biocatalytic Membrane Nanosystems* (BMNs) that mimic the structure and function of enzymes in natural processes for applications in pharmaceutical biocatalysis. In BMNs, enzymes are confined to the nanoreactor (Figure 1B) by highly porous membrane layers [1-3], which enable fast diffusion of small reactant and product molecules and prevent the escape of much larger enzymes. Two bacterial enzymes, a lipase and cytochrome catalyzing hydrolysis and selective oxidation of pharmaceutical intermediates, respectively, are being investigated due to high potential practical and fundamental impacts of corresponding biocatalytic processes. Our studies to date have focused on understanding how the lipase efficiency is affected by the surface chemistry and pore size of the membrane layers. These studies indicated that lipase interacted strongly with the hydrophobic surfaces without experiencing a loss in biocatalytic activity, while charged surfaces resulted in weak interactions and somewhat decreased biocatalytic activity [4]. Moreover, the diffusion of the reactant and product molecules across the porous material of the membrane layer was fast when the pore size was larger than 5 nm [5]. Future work will focus on integrating a nanoreactor containing optimized surface functional groups, cytochrome and its co-factor into the BMN architecture and investigating the biocatalytic efficiency of these devices in selective oxidation of pharmaceutical intermediates.

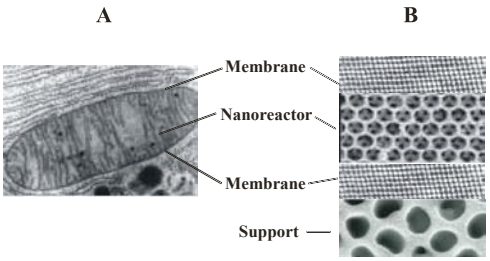

Figure 1. Natural and biomimetic biocatalytic systems: (A) mitochondrion (~5 μm in size) and (B) BMNs.

References

[1] For further information about this project: http://alpha.che.uc.edu/matcat or email Vadim.Guliants@uc.edu
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[4] A. Katiyar, S. Zheng, V.V. Guliants and N.G. Pinto, "Immobilization of *Pseudomonas Cepacia* Lipase in Ordered Mesoporous Silica: Effect of Pore Confinement on Biocatalytic Activity", *Langmuir*, submitted.
[5] A. Katiyar, S. Zheng, V.V. Guliants and N.G. Pinto, "Immobilization of *Pseudomonas Cepacia* Lipase in Ordered Mesoporous Silica: Effect of Surface Chemistry on Biocatalytic Activity", *Langmuir*, submitted.