Department of Chemical Engineering Presents:

HAJIM SCHOOL OF ENGINEERING & APPLIED SCIENCES
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Synergy of Protein and Genome Engineering for Fuels and Chemicals Production

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The sustenance of transportation fuel and chemical industries has insofar been raw materials derived from non-renewable sources such as petroleum, natural gas, and coal. With increasing concerns about energy security and sustainability, equivalent molecules derived from renewable plant biomass have become the frontrunner as promising alternatives. In addition, the detrimental environmental effects caused by synthetic chemical processes have further motivated the development of "green" biotechnology for the production of value-added chemicals. Unfortunately, natural enzymes and microbes did not evolve for industrial application. Resultantly, significant research has been devoted to engineering them for new, efficient, environmentally-friendly, and cost-effective processes. Enzyme properties such as stability, activity, and substrate or product specificity are now routinely modified. Recent advances in metabolic engineering and systems biology have also enabled the creation of recombinant microbes for the production of complex molecules such as amino acids, fuels, and antibiotics.

However, both engineered proteins and genetically modified microbes have limitations. For example, proteins engineered with altered activity often suffer from inadvertent side-effects such as lowered catalytic efficiency or stability due to disruption of the intricate amino acid interactions. Similarly, highly genetically modified microbes may exhibit incidental debilitations such as lowered growth rates and productivity. To minimize such inefficiencies, my interest was in exploring the potential benefits of combining protein engineering and microbial genome engineering. Using the development of a selective biocatalyst for the production of xylitol (a sugar substitute and platform chemical) as a test case, I employed each of the aforementioned strategies individually to the point where their limitations start to manifest. Thereafter, I examined effect of combining the two in a single system. The results show that the combination of the two efforts is synergistic, rather than simply additive. This protein-microbe co-engineering strategy developed here should be applicable to the development of more robust and effective bioprocesses.