



Understanding and Harnessing the Power of Microbial Communities: System and Synthetic Biology Approaches

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Seminar Room, 1st Floor of the Science Frontier Laboratory, Medical Campus
(Bldg. no. 16 in the campus map: <https://www.kyoto-u.ac.jp/en/access/medicine-campus-map>)

Microbes are everywhere in nature and they live in diverse communities that show remarkable metabolic capabilities and robustness. On the other hand, disruption of microbiome homeostasis and associated changes in the community's structure/function underlies numerous health or environmental issues. My lab has been developing methods and tools rooted in engineering to study microbial communities in order to discover the underlying ecological, cellular, and molecular mechanisms. In particular, we have pioneered a technological pipeline, based on nanoliter-scale water-in-oil microfluidic droplets, to co-cultivate sub-communities and characterize interactions between community members. A number of technological modules have been created and the pipeline is being applied to the investigation of a range of health or environment related microbiomes. A second distinct yet complementary research thrust in my lab, inspired by naturally occurring synergistic microbial communities, has been the design and construction of synthetic consortia for microbial engineering. As an example, we have developed a high-throughput strain screening method based on compartmentalized co-cultivation. We have also engineered a portfolio of modular microbial consortia for bioprocessing. For instance, to make use of lignocellulosic biomass, we designed and optimized a consortium consisting of a cellulolytic fungus capable of hydrolyzing hemicellulose and cellulose (main components of lignocellulosic biomass) into mono and oligosaccharides and a genetically engineered bacterium for converting mono and oligosaccharides into isobutanol, an advanced biofuel. The general framework of engineering defined co-cultures of coordinated specialists offers tremendous potential for developing novel biotechnologies for numerous applications in biomanufacturing and bioremediation.

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