Michelle O’Malley earned her B.S. in chemical engineering and biomedical engineering from Carnegie Mellon University. She then went on to complete her Ph.D. in chemical engineering at the University of Delaware, where she worked with Professor Anne Robinson to engineer overproduction of membrane proteins in yeast. O’Malley was a postdoctoral fellow in the Department of Biology at Massachusetts Institute of Technology, where she developed new strategies for cellulosic biofuel production. At the University of California, Santa Barbara, her research focuses on engineering protein synthesis within anaerobes and consortia for sustainable chemical production, bioremediation, and natural product discovery. O’Malley was named one of the 35 Top Innovators Under 35 by MIT Technology Review in 2015, and she is the recipient of a DOE Early Career Award, an NSF CAREER award, a Hellman Faculty Fellowship, a USDA-NIFA Postdoctoral Fellowship, a Whiting Foundation Fellowship, and a NASA-Harriett G. Jenkins pre-doctoral fellowship.

Exploiting Anaerobes for Biomass Breakdown and Sustainable Chemistry

Renewable chemicals derived from plant biomass (mainly composed of cellulose and lignin) are attractive alternatives to those made from petroleum. To produce chemicals from biomass, enzymes are used to break down cellulose into simple sugars, which are later fermented into value-added products. However, since cellulose is tightly bound within a network of crystalline cellulosic fibers and lignin, existing biomass degrading enzymes are not very efficient. To develop new technologies to break down plant material into sugar, much can be learned by studying how microbes digest lignocellulose in biomass-rich environments, such as the digestive tract of large herbivores. Anaerobic fungi are native to the gut and rumen of these animals, where they have evolved powerful enzymes to degrade plant biomass. Our goal is to develop new experimental tools to engineer anaerobic fungi and anaerobic microbial consortia for lignocellulose breakdown and chemical production. To accomplish this goal, we isolated a panel of anaerobic fungi and associated microbes from different herbivores and screened for their ability to degrade several types of lignin-rich grasses and agricultural waste. By focusing on model anaerobic fungi from the Piromyces, Neocallimastix, and Anaeromyces genera, we have employed next-generation sequencing to discover thousands of new genes, revealing hundreds of novel biomass-degrading enzymes. Additionally, we have characterized key regulatory patterns for these enzymes, which depend on the environment of the fungus. Using this information, we are developing new genetic engineering strategies to manipulate gut fungi at the molecular level, along with ‘bottom-up’ strategies to synthesize microbial consortia for compartmentalized breakdown and bioproduction.