How novel phenotypes evolve is a central question in evolutionary biology. Given the ubiquity of bacteria in virtually all environments, it is imperative to consider how bacteria contribute to the diverse phenotypes, ecology, and biology found on Earth. By hosting bacteria, many animals gain access to bacterial metabolism, enabling hosts to occupy restrictive ecological niches. I study physiological evolution in animal/bacteria systems. By integrating diverse methodologies across biological scales of organization, my research addresses the mechanisms by which bacterial metabolism drives evolution of phenotypic and ecological novelty in animal hosts. Animal/bacteria associations range from highly integrated systems with vertically inherited symbionts (like the aphid/\textit{Buchnera} system) to systems that acquire taxonomically variable communities from the environment (like \textit{Drosophila}) – all of which can shape host phenotypes and adaptive trajectories. My research program investigates insect/bacteria systems on the two ends of the spectrum to address fundamental questions about the functional roles and mechanisms of bacterial metabolism in the evolution of diverse animal phenotypes and ecological contexts.