Humans and other living organisms in the environment routinely experience a variety of environmental factors from dietary uptake to pollutant exposure. Microbiome, collection of microorganisms, plays critical roles in mediating how environmental factors affect health and diseases. Particularly, intriguing roles of animal microbiome in regulating host nervous systems, namely the microbiome-gut-brain axis, have drawn much attention in recent years for understanding disease mechanisms and its promising applications in future biomedicine. With tools from analytical chemistry, toxicology, microbiology and neuroscience, the Qiu lab is interested in elucidating the chemical basis of environment-host-microbe interactions with an emphasis on the microbiome-gut-brain axis and linking the chemical and molecular mechanisms to animal physiology and behavior.

Mass spectrometry methods for microbiome-gut-brain axis – Altered microbiota are correlated to various neurological diseases from enteric to central nervous systems. Gut microbial species can affect host nervous system via many pathways, including regulating levels of neurochemicals from classical biogenic amines to neuropeptides and hormones. One primary research goal of the Qiu lab is to develop mass spectrometry-based methods for neurochemicals from gut microbes and in animal samples. With matrix-assisted laser desorption/ionization (MALDI) coupled with a time-of-flight (TOF) mass analyzer ***(Figure 1)***, MALDI-TOF mass spectrometry provides capabilities to visualize the spatial distribution of chemicals and screen chemical contents in a high-throughput manner. Liquid chromatography coupled with various mass spectrometers (LC-MS) can be used for structural analysis and quantification of analytes. Together with microbiology techniques and animal models, these mass spectrometry-based methods will help us to understand the chemical basis of the microbiome-gut-brain axis and explore their potential for future microbiome-based neurological disease interventions.

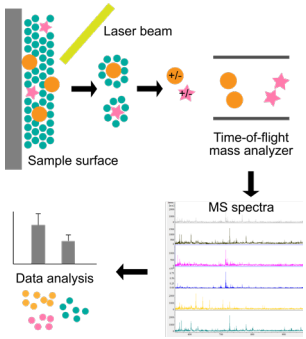


Figure 1. Illustration for the working principle of a MALDI-TOF mass spectrometer.

Environmental toxicology research for nanotechnology – Microbiome can mediate the effects of environmental pollutants on human health and the ecosystem. The extremely small size (10^{-9} m) of engineered nanoparticles (ENPs) gives them high reactivities and unique properties desirable in many emerging technologies, enabling future markets of billions. However, the risk of these reactive materials to environment needs to be thoroughly investigated to prevent negative consequences. Another focus area of the Qiu lab is to understand how microbiome mediates ENP toxicity to animals with an emphasis on neurotoxicity. Utilizing the powerful model animal, the nematode *Caenorhabditis elegans* (*C. elegans*), and various microbial models, we aim use a nano-host-microbe experimental scheme and combine interdisciplinary approaches to discover important molecular mechanisms in gut microbiome-mediated ENP toxicity to animals ***(Figure 2)***, providing guidance for the involvement of microbiota in future environmental risk assessment.

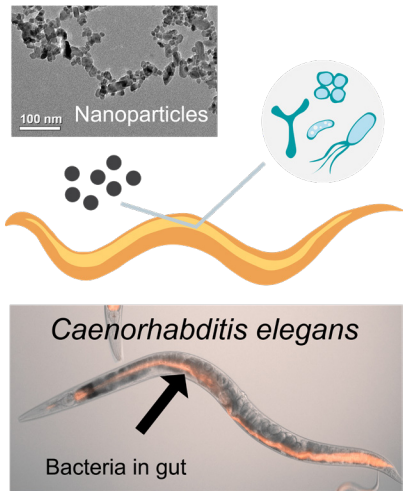
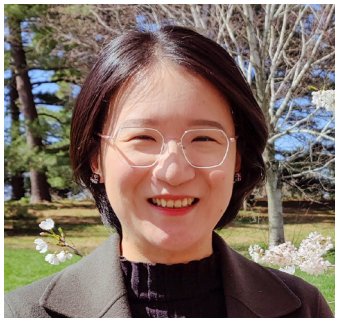


Figure 2. A nano-host-microbe experimental scheme, illustrating the nematode* C. elegans *with bacteria residing in gut as well as a TEM image of TiO_2 nanoparticles.

Bacterial cell wall, high glucose exposure and aging – High glucose exposure can cause toxicity that is related to obesity and type 2 diabetes, diseases correlated with aging and reduced lifespan. A widely used model for aging studies, *C. elegans* has well-conserved signaling pathways implicative of aging in human. High glucose was shown to reduce *C. elegans* lifespan, and our previous study showed that the bacterial diet fed to *C. elegans* could mediate glucose-induced lifespan reduction via enzymatic activities related to bacterial cell wall synthesis. We aim to further extend the research to understand the molecular mechanisms of the interactions among high glucose exposure, bacterial cell wall structure and aging using our interdisciplinary approaches from mass spectrometry to *C. elegans* biology. With increasing sugar consumption being a public health issue, we hope this research can shed light on how microbiome may regulate hosts' response to high glucose exposure and pave ways for future microbiome-involved interventions and evaluations for sugar consumption risks and related diseases.



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Selected Publications

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