Zezong Gu

Research in the Gu laboratory focuses on the studies of traumatic brain injury (TBI) and cerebral ischemia, associated aging-related neurodegenerative diseases in animal models for mechanistic and translational investigations in aiding for the development of biomarkers, preventive and therapeutic strategies.

1) Redox modulation, particularly molecular mechanisms of perturbations in cell-cell and cell-matrix signaling due to nitrosative and oxidative stress, resulting in neurovascular impairment in neurodegenerative diseases.

2) Roles of matrix metalloproteinases (MMPs) in the pathogenesis of ischemic and traumatic brain injuries.

The Gu laboratory uses multi-disciplinary approaches and paradigms to conduct translational research. The Gu laboratory toolbox includes cell-free protein interaction, primary neuron cultures including biofidelic 3D cultures, and in vivo rodent models of neurodegenerative diseases, as well as neurobehavioral assessment, digital pathology and quantitative proteomic analyses and bioinformatics.

Nitrosative/oxidative stress alters functions of both extracellular and intracellular key molecules, contributing to neuronal cell death and injury, mitochondrial fragmentation, protein misfolding, transcriptional regulation, and redox homeostasis. Dr. Gu's lab has demonstrated that botanicals and their active components are able to mitigate nitrosative/oxidative stress and inflammatory responses in neurons and glial cells, as well as protect the brain against cerebral ischemic injury. Dr. Gu discovered a novel signaling cascade activating MMP-9 through S-nitrosylation, resulting in excessive extracellular proteolysis which leads to neuronal apoptosis. A highly specific inhibitor SB-3CT blocks MMP-9 activity, rescues neurons from apoptosis, and ameliorates neurovascular impairment from both ischemic and traumatic injuries. Dr. Gu demonstrated that activatable cell-penetrating peptides reveal in vivo MMP-9 activity as a surrogate indicator of MMP-mediated neurovascular impairment. His lab applied systems biology by developing a number of cutting-edge techniques for quantitative proteomics, such as nitroDIGE as well as with isobaric reagents including iodoTMT and DiART, to globally profile differential levels of proteins and to detect specific cysteine-based protein translational modifications (PTM). These quantitative proteomic techniques allow his lab to investigate redox-based protein modulation in the nervous system. Ultimately, the endeavor of Dr. Gu's studies supported with these techniques and resources may lead to identifying potential biomarkers and therapeutic targets for neurodegenerative diseases. Dr. Gu is also passionate about the training of scientists, physicians, and graduate students from all over the world, which as of now includes Mexico, Puerto Rico, China, Indian, Japan, Philippines, Turkey, Israel, Libya, Cote D'lvoire, Ghana, Nigeria, Cameroon, and South Africa.