Juan Mena Segovia Laboratory

Within the rapidly advancing field of neuroscience, our multidisciplinary lab focuses on understanding the complex processes through which the brain interprets, integrates, and responds to environmental stimuli. Our research delves into the mechanisms by which the brain merges incoming data with past experiences to formulate and execute decisions, an essential function for both survival and adaptation.

Central to our research are the midbrain and basal ganglia. These subcortical structures play a critical role in orchestrating our responses to environmental shifts, thus shaping our behavior to maximize adaptation and success. We are especially interested in characterizing the structural organization, communication, and interaction of motor and limbic neurons within these regions. We aim to decipher the neural codes of adaptive behavior during decision-making and action selection across cellular, circuit, and behavioral levels. This includes an in-depth exploration of how the connectivity of inhibitory, excitatory, and neuromodulatory neurons (e.g., acetylcholine and dopamine) in the midbrain influences the activity of basal ganglia circuits, and how these neurons integrate incoming information to support flexible behavior, ultimately culminating in motor responses.

To accomplish our research objectives, we employ a comprehensive and multifaceted set of techniques that span a broad spectrum from ultrastructural anatomy to a suite of behavioral tasks. These include neuronal tracing, in vitro slice recordings, in vivo electrophysiological recordings, optogenetics, chemogenetics, and calcium imaging. Our approach at the individual neuron level aims to identify their molecular markers, physiological properties, and how they integrate into local networks. Furthermore, in recognizing the critical role of neuromodulators in learning and behavior acquisition, our methodology extends to studying how these agents influence the behavioral state and enhance neural computations within functionally integrated ensembles across extensive brain regions. This integrative approach allows us to investigate how the brain processes new information and how it integrates this information into a coherent behavioral framework. Last but not least, by dissecting and understanding the complex rules of midbrain neural interactions, we aim to address the underlying dysfunctions in neuron and circuit communication during disease, opening new pathways for insights and therapeutic interventions in neuroscience.

The Beckman Scholar will be part of a dynamic research team, integrating into projects that tackle neurological conditions like Parkinson’s disease and progressive supranuclear palsy, as well as the processes of recovery following spinal cord injuries. Through hands-on work with animal models, the Beckman Scholar will explore the cellular mechanisms behind motor and cognitive dysfunctions. With the support and mentorship of graduate students and senior researchers, the Beckman Scholar will master key anatomical and behavioral research techniques, gaining insights into the neural pathways of dysfunction and recovery. The role involves running experiments, analyzing brain tissue, and presenting findings in lab meetings and potentially at a national conference. This opportunity strikes a balance, offering a rigorous introduction to neurological research within an engaging and collaborative setting.