

2021 Chen Institute Symposium

Speaker: Emery N. Brown

Talk Title: Deciphering the Dynamics of the Unconscious Brain Under General Anesthesia

Abstract: General anesthesia is a drug-induced, reversible condition comprised of five behavioral states: unconsciousness, amnesia (loss of memory), antinociception (loss of pain sensation), akinesia (immobility), and hemodynamic stability with control of the stress response. Our work shows that a primary mechanism through which anesthetics create these altered states of arousal is by initiating and maintaining highly structured oscillations. These oscillations impair communication among brain regions. We illustrate this effect by presenting findings from our human studies of general anesthesia using high-density EEG recordings and intracranial recordings. These studies have allowed us to give a detailed characterization of the neurophysiology of loss and recovery of consciousness due to propofol. We show how these dynamics change systematically with different anesthetic classes and with age. As a consequence, we have developed a principled, neuroscience-based paradigm for using the EEG to monitor the brain states of patients receiving general anesthesia. We demonstrate that the state of general anesthesia can be rapidly reversed by activating specific brain circuits. Finally, we demonstrate that the state of general anesthesia can be controlled using closed loop feedback control systems. The success of our research has depended critically on tight coupling of experiments, signal processing research and mathematical modeling.