Metabolic communication between the body and the brain

Li Ye
Dorris Neuroscience Center, The Scripps Research Institute, La Jolla, CA, USA

A hallmark of evolution is the increasing size, complexity, and metabolic demand of the brain, which requires coordinated support from the body. To sustain normal brain function, the central nervous system's (CNS) energetic needs must be regulated at the organismal level. My lab investigates neural energetics across multiple scales—from behaviors and circuit dynamics to autonomic control of peripheral organs and intracellular metabolism—to understand the bidirectional metabolic interactions between the brain and body.

Recently, we used cold exposure as a model to study natural energetic conflicts between the brain and body. Maintaining body temperature in the cold poses a significant challenge for mammals, requiring the brain to dynamically process exteroceptive and interoceptive signals to balance physiological (e.g., thermogenesis) and behavioral (e.g., food intake) priorities. We identified an afferent pathway through which the brain senses metabolic information from adipose tissues and regulates thermogenic activity (Wang et al., 2022 & 2025). Additionally, we found that cold-induced thermogenesis activates a lesser-known thalamic nucleus involved in gating behavioral choices between energy expenditure and conservation (Lal, 2023).

Through these models, we aim to uncover how the brain perceives metabolic states, modulates neural circuits, and synchronizes behavioral and physiological regulation. This understanding could reveal overlooked principles of brain function shaped by bottom-up inputs and metabolic constraints, with broad implications for the pathophysiology of both peripheral and neurological diseases.