

GUT-BRAIN AXIS: MECHANISMS AND REGULATION

Vinicius Willian Calderon da Silva

Vitor Padovan Piacenti (Universidade de Marília); Rafael de Oliveira Tabian (Universidade de Marília);
Sandra Maria Barbalho (Universidade de Marília)

RESUMO

Introduction: The gut-brain axis is a bidirectional communication network that integrates the intestinal microbiota, the central nervous system, immunity, and endocrine regulation. Within the neural component, the vagus nerve serves as the main pathway for transmitting intestinal signals, modulating cognition, satiety, and mood. Changes in the microbiota influence the hypothalamic-pituitary-adrenal axis, intensifying stress responses and affecting energy metabolism. Meanwhile, intestinal dysbiosis promotes increased permeability and activation of pro-inflammatory cytokines, contributing to neuroinflammation and the risk of neurological disorders. These mechanisms highlight the central role of microbiota in neuroendocrine and immune regulation. **Objective:** To understand the endocrine, neural, inflammatory, and microbial metabolite mechanisms and their regulation in the gut-brain axis. **Material and Methods:** A narrative literature review was conducted using articles indexed in PubMed, covering publications between 2019 and 2026 on the physiological mechanisms involved in the gut-brain axis. Studies related to neural mechanisms, endocrine regulation, inflammatory processes, and metabolites produced by the intestinal microbiota were analyzed. **Results:** The studies showed that the gut-brain axis functions as a complex bidirectional system of interaction between the intestinal microbiota, immune system, endocrine system, and central nervous system. Among the neural mechanisms, the vagus nerve stood out as the main pathway for transmitting intestinal signals, influencing cognition, satiety control, energy metabolism, and emotional regulation. In endocrine mechanisms, changes in the composition of the intestinal microbiota were observed to directly affect the hypothalamic-pituitary-adrenal axis, promoting alterations in cortisol release and intensifying responses to chronic stress and factors associated with obesity, diabetes, anxiety, and depression. Regarding inflammatory mechanisms, intestinal dysbiosis favored increased intestinal permeability, translocation of bacterial endotoxins, and activation of pro-inflammatory cytokines, contributing to neuroinflammation and a higher risk of developing neurodegenerative and psychiatric diseases. Furthermore, microbial metabolites, especially short-chain fatty acids (SCFAs), showed neuroprotective effects by regulating microglial activity, neurotransmitters, neuronal plasticity, memory, mood, and cognitive function. These findings reinforce the importance of the intestinal microbiota in neuroimmune and neuroendocrine regulation, highlighting the gut-brain axis as a potential therapeutic target for neurological, metabolic, neuropsychiatric, and inflammatory diseases.

Conclusion: The gut microbiota exerts a multifactorial influence on systemic and cognitive health, acting as a regulatory hub that integrates neural pathways-such as the vagus nerve-and endocrine signaling via the hypothalamic-pituitary-adrenal axis. The production of metabolites, such as short-chain fatty acids, and the modulation of inflammatory processes demonstrate that gut symbiosis is fundamental for neurobiological and metabolic control during physical activity. Understanding these complex mechanisms reinforces the potential for interventions based on microbiota modulation to optimize cognitive and physical performance, although translating these mechanistic findings into human clinical practice still requires further in-depth and validated research.

Palavras-chave: Gut Microbiota Gut-brain Axis Physical Exercise Short-chain Fatty Acids Neuroinflammation.