Title of Project： Census-based biomechanism of circuit construction and transition for adaptive brain functions (Adaptive Circuit Census, ACC)

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【Purpose of the Research Project】

In order to survive, all animals need to adapt their behavior depending on internal and external conditions. This behavioral adaptation is achieved by constructing and altering numerous neuronal activities and circuits (*adaptive circuits*). In this project area, we will focus on the circuit construction and transitions responsible for adaptive brain functions. Combining advanced neuroscience techniques for measuring and manipulating neural circuit activity with cutting-edge techniques for single-cell gene expression analysis will provide detailed information about cell type-specific adaptive circuits (*adaptive circuit census*). Based on the adaptive circuit census, we will experimentally validate the responsible circuits and theoretically establish their operating principles.

【Content of the Research Project】

In the field of neuroscience, dramatic development of advanced technologies has enabled optical observation and manipulation of large numbers of neurons. However, most of these methods are based solely on conventional neuronal markers or their promoters, and consequently lack cell-specific circuit resolution. To reveal the precise mechanisms of adaptive circuits, we have awaited the emergence of innovative technology that allows us to classify and manipulate individual neurons. Nowadays, rapid innovation of single-cell RNA sequencing (scRNA-seq) technologies has made it possible to dissect cell-type specificity and comprehensively analyze gene expression patterns in individual living cells, providing a novel way to perform experimental neuroscience. By combining those techniques, we will reveal the actual adaptive circuits that control animals' behavior and reveal their connectivity and operating principles.

To promote the project area, we have established a seamless, interdisciplinary cooperative framework to exchange creative and innovative ideas as well as cutting-edge experimental and analytical techniques. The project subareas are divided into A01, "*Census of adaptive circuit construction*," and B01, "*Census of adaptive circuit transition*," based on the differences of the timescale. In addition, the project subarea C01, "*Technology and theory for adaptive circuit census*," interacts with A01 and B01 to facilitate targeting of adaptive circuits.

The A01 project subarea is organized by the Horie, Shimogori, and Fujiyama teams; the B01 project subarea is organized by the Isomura, Sasaki, and Kobayashi teams; and the C01 project subarea is organized by the Go and Shimazaki teams. In addition, publicly invited research teams will participate in each project subarea in the first and second terms of the project area.

A seamless neuroscience research group, such as one that combines single-cell gene analysis techniques and circuit manipulation, has not been effectively created in Japan. Therefore, we established the research support committee (histological analysis, physiological analysis, behavioral analysis, gene manipulation, and theoretical /statistical analysis support teams) and transcriptomic analysis support committee (collaboration coordination and RNA-seq analysis unit) within the executive committee of the administrative organization.
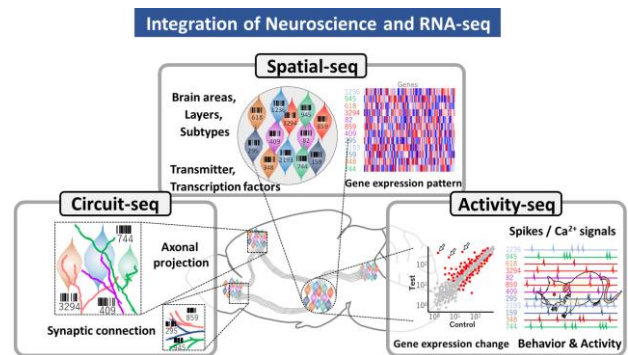
【Expected Research Achievements and Scientific Significance】

In our Research Area, we will promote interdisciplinary research to clarify the mechanisms of adaptive circuits at the single-cell resolution by integrating multiple technological streams. Another main aim is cultivating the next generation of neuroscience inspired by the challenging ideas of young and energetic researchers. Knowledge of the adaptive circuit census should bring about clinical therapies targeting neuropsychiatric disorders with fewer side effects, the development of artificial intelligence, and robotics with power-saving and noise-resistant features.

【Key Words】

Adaptive circuit census: Research strategy that combines advanced neuroscience techniques with single-cell gene expression analysis to reveal the circuit construction and transitions responsible for adaptive brain functions.

【Term of Project】 FY2021-2025

【Budget Allocation】 1,115,300 Thousand Yen

【Homepage Address and Other Contact Information】
https://ac-census.org/