Title of Project : Mesoscopic neurocircuitry: towards understanding of the functional and structural basis of brain information processing

Term of Project : FY2010-2014

Akinao Nose
(The University of Tokyo,
Graduate school of Frontier Sciences,Professor)

【Purpose of the Research Project】

Progress in genome biology in the past decades greatly advanced our understanding of the brain at the microscopic level. Similarly, recent developments in brain imaging have facilitated macroscopic analyses of brain regions. However, amazingly little is known about the phenomena occurring at the intermediate, mesoscopic level. In this research area, we focus on mesoscopic neurocircuitry (meso-circuits), and try to understand the logic of brain information processing. We analyse the structural and functional connectivity of meso-circuits by using recently advanced techniques, such as cellular imaging, optogenetics and systematic mathematical modeling. Through collaborative work of researchers from different disciplines, we aim to elucidate the operating principle of neural circuits and thus fill the gap in our understanding of the brain.

【Content of the Research Project】

The research project consists of the following five steps.

1) Identification of meso-circuits from complex brain (e.g. visualization of the circuits by molecular markers).

2) Recordings of neural activity within the circuits (e.g. patch-clamp, calcium imaging).

3) Perturbation of neural activity within the circuits (e.g. activation and inactivation of neural activity by optogenetics, genetic alteration of neural wiring).

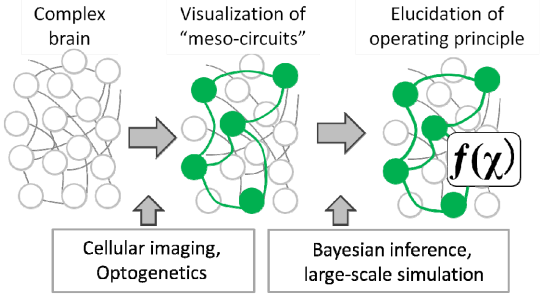

Figure 1 Strategy of the research project.

4) Systematic experimental analyses of input-output relationship of the neural circuits (e.g. combination of step 3 and 4)

5) Theoretical analyses of the large-scale data concerning the structural and functional connectivity of the circuits (e.g., Bayesian inference, large-scale simulation).

【Expected Research Achievements】

Deciphering the operating principles of meso-circuits will greatly enhance our understanding of the brain because it enables one to relate the knowledge about the microscopic phenomena (e.g. dynamics of molecules and cells) to the knowledge about macroscopic phenomena (e.g. activity of brain regions). Our approach will also lead to development of "neural" robots based on the operating principle of meso-circuits and new interpretation of brain diseases.

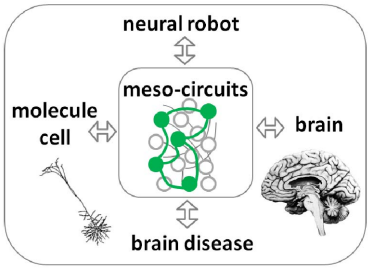

Figure 2 Development to other research areas.

【Key Words】

Mesoscopic neurocircuitry: small-scale neural circuits that function as units of brain information processing. An example are circuits found in cerebellum. However, such circuits are yet to be identified in most brain regions.

Optogenetics: A recently developed method that combines optical and genetic techniques to probe and manipulate neural activity.

【Homepage Address】

http://www.meso-neurocircuitry.jp/index.html