Systems Neurophysiology

1. Staffs and Students

Professor	Izumi Sugihara
Associate Professor	Yuriko Sugiuchi
Lecturer	Yoshiko Izawa (Feb. 2010~)
Assistant Professor	Yoshiko Izawa (~Jan. 2010), Mayu Takahashi (Apr. 2010~)

2. Education

We participate in "Cell Biology II (Function of Cells)" (lectures, 1st grade), "Neuroscience" (systematic lectures, 2nd and 3rd grades) and "Physiology Lab" (3rd grade) courses for medical students as well as in courses for graduate students. We mainly teach neurophysiology parts in these courses. The goal of our education is for students to understand normal function of nerve cells and the nervous system and, on this ground, to understand pathological states of the nervous system in diseases. For this purpose, we give clinically-oriented lectures and laboratory courses linked with morphology and pharmacology. They cover transport and potential of the cell membrane (Cell Biology), excitation and synaptic transmission, sensory systems, motor systems, autonomic nervous systems, and higher brain function (Neuroscience), i.e. neurophysiology in general from cellular through organismic levels. To support for students to learn for themselves basic matters such as generation and propagation of excitation in nerve cells, we developed a hand-made computer simulation program for a part of the laboratory course.

3. Research

Our main interest lies in neural mechanisms of motor control. We analyze morphology and function of neural networks of the central nervous system (mainly the cerebellum, brainstem and cerebrum) for controlling initiation and cessation of various kinds of eye movements by combining morphological, electrophysiological, and cell-biological methods.

1) Cerebellar function

The neuronal circuitry that connects the cerebrum, pontine nuclei, cerebellar cortex (hemisphere), cerebellar nucleus (dentate nucl.), thalamus and cerebrum is important for initiation, execution and control of movements. Distinct regions in the cerebellum make specific connections with different areas of the brainstem and are involved in the control of various movements including eye movements. To understand cerebellar function, it is important to have exact idea about cerebellar divisions into such distinct regions as well as specific neuronal circuitry of the regions, and to reveal the principle based on which the cerebellum is organized into regions and functions by way of the input and output systems. Our systematic approach to this question includes electrophysiology, neuronal labeling with marker molecules and tracers, single-axonal reconstruction, three-dimensional mapping of neuronal projection patterns.

2) Neural mechanism of eye movement control

An animal fixates on interesting target by moving its eyes and head. This eye-head coordination system is very interesting as a model of motor control in the central nervous system of higher mammals. To understand the mechanism of the visuo-motor transformation in eye movement system, we analyze neural mechanisms of signal transformation from the superior colliculus (center for rapid gaze shifts) to the brainstem, the midbrain, and the spinal cord using electrophysiological and morphological methods. Furthermore, we analyze the mechanisms for the control of eye movements and visual fixation in the systems from the frontal and parietal cortices to the superior colliculus and the brainstem.

4. Publications

Original Articles

1. Fujita, H., Oh-Nishi, A., Obayashi, S., Sugihara, I. (2010) Organization of the marmoset cerebellum in three-dimensional space: lobulation, aldolase C compartmentalization and axonal projection. *J. Comp. Neurol.* 518: 1764-1791.
2. Takahashi, M. Sugiuchi, Y. Shinoda, Y. (2010) Topographic organization of excitatory and inhibitory commissural connections in the superior colliculi and their functional roles in saccade generation. *J. Neurophysiol.* 104: 3146-3167.
3. Oh-Nishi, A., Obayashi, S., Sugihara, I., Minamimoto, T., Suhara, T. (2010) Maternal immune activation by polyriboinosinic-polyribocytidilic acid injection produces synaptic dysfunction but not neuronal loss in the hippocampus of juvenile rat offspring. *Brain Res.* 1363:170-179.

Book Chapters

1. Sugihara I, Fujita H. (2010) A computer-aided light microscopy system for three-dimensional reconstruction of axonal projections. In: A. Méndez-Vilas and J. Díaz eds. Microscopy: Science, Technology, Applications and Education, Microscopy Book Series No. 4., Badajoz: Formatex. pp. 813-819